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## ECLIPSE PHOTOGRAPHS, MAY 28-29, 1919.

The two plates I and II which we present as the frontispiece to this number of POPULAR ASTRONOMY have been copied from plates in the November number of *The Observatory*. The first shows the corona as it was photographed at Sobral, Brazil, with a 4-inch lens of 19 feet focus. "The middle of the exposure was May $28^d$ $23^h$ $59^m$ $52^s$ G.M.T. and, as the length of the exposure was 28 seconds, the exposure began on May 28 and ended on May 29 (astronomical reckoning).

"On the second plate are reproductions of the large prominence which occurred on the Sun's eastern limb. The mid-times of the exposures are given under the two pictures, and it will be seen that there was an interval of more than 2 hours between them. The first of these plates was taken with a 4-inch lens, with 28 seconds' exposure, at Sobral; the second was taken with the Oxford astrographic lens—focal length 11 ft. 3 in.,—with the aperture cut down to 8 inches and with a 10 seconds' exposure, at Principe.

"Considerable change in the form of the prominence between the two exposures will be seen, but it should be remarked that the lower part of the prominence is eclipsed in the first picture. The prominence extends roughly from the east point of the Sun (right of picture) to 40° S. These two photographs were obtained through cloud. As the purpose of the expedition was to photograph stars in the neighborhood of the Sun, the lengths of the exposures were fixed so as to give good images of the stars in a clear sky. The length of exposure suitable for the stars was also sufficient to show the corona, but gave very over-exposed images of the prominence. The clouds spoilt the plates so far as the immediate object of the expeditions was concerned, but caused excellent photographs of the prominence to be secured.

"For all the plates, the tube carrying the lens was fixed in a nearly horizontal position, and the light was thrown on to the lens by a coelostat mirror."

Photographs of the same prominence taken with the spectroheliograph at Yerkes Observatory on the same date show some of the same features and some very interesting changes which occurred during the day. Reproductions of some of these photographs are given in the October, 1919, number of the *Astrophysical Journal*.

## TWENTY-THIRD MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 677, Vol. XXVII)

### PEIRCE'S CRITERION.

By R. M. STEWART.

Of the various criteria which have been proposed for the rejection of discordant observations, with the object of eliminating "the arbitrary discretion of individual computers", that due to Dr. Peirce is perhaps the only one which has attained to wide-spread use. The object of this paper is to examine the reasoning therein.

The fundamental principle which he lays down as the foundation of the mathematical reasoning is that, in a series of $N$ observations, the $n$ observations showing the largest residuals should be rejected when the probability of the system of errors obtained by retaining them is less than that of the system of errors obtained by their rejection multiplied by the probability of making $n$ and no more abnormal observations.

It may be remarked at the outset that the principle as stated is erroneous when $n$ is greater than unity. For let $P_0$ be the probability of the system of errors obtained by retaining all observations, and $P_1$, $P_2$ ------ $P_n$ the probabilities of the systems obtained by the rejection of 1, 2 ------ $n$ observations (embodying the probabilities of making 1, 2 ------ $n$ abnormal observations). Now it is obvious that $P_1$, $P_2$ ------ $P_n$ may all be greater than $P_0$, while one of them $P_r$ $(r<n)$ may be greater than any of the others. Obviously then the system obtained by rejecting only $r$ observations is the most probable, while the above principle would call for the rejection of $n$ observations. Hence his reasoning must be restricted to the case $n = 1$.

Let $y$ be the probability, supposed unknown, that an observation is of the abnormal character which involves its rejection.

Let $\psi(\kappa)$ be the probability of a normal error which exceeds the limit $\kappa\epsilon$ ; then

$$\psi(\kappa) = \frac{2}{\sqrt{\pi}} \int_{\frac{\kappa}{\sqrt{2}}}^{\infty} e^{-t^2} dt .$$

Peirce finds

$$P_0 = \frac{h_0{}^{N-1}}{\pi^{\frac{N-1}{2}}} \cdot e^{-h_0{}^2(\Sigma\Delta_0{}^2 - \kappa^2\epsilon_0{}^2)} \times \psi(\kappa)$$

$$P_1 = \frac{h_1{}^{N-1}}{\pi^{\frac{N-1}{2}}} \cdot e^{-h_1{}^2\Sigma\Delta_1{}^2} \times p(1-p)^{N-1}$$

where $\Sigma\Delta_0{}^2$ is the sum of the squares of all the residuals

$\Sigma\Delta_1{}^2$ is the sum of the squares of the $N-1$ residuals obtained from a new solution, rejecting the doubtful observation.

He proceeds to find the limiting value of $\kappa$ from the inequality $P_0 < P_1$, or by simplification

$$\left(\frac{\epsilon_1}{\epsilon_0}\right)^{N-1} \cdot e^{\frac{\kappa^2-1}{2}} \times \psi(\kappa) < p\,(1-p)^{N-1}$$

*on the assumption that* $P_1$, *and therefore* $p\,(1-p)^{N-1}$ *must have its maximum possible value,* or that $p = \frac{1}{N}$.

Herein lies the fallacy which vitiates the whole reasoning. Of the actual value of $p$ we know nothing; we do know, however, that it is a function of (among other things) the liability to mistakes of the particular observer involved, and will therefore vary with different observers; nor is there any reason why it should so adjust itself as to make $P_1$ a maximum.

The most we can conclude is that $p\,(1-p)^{N-1}$ cannot be greater than $\frac{(N-1)^{N-1}}{N^N}$ the value attributed to it by Peirce, and that therefore if all residuals are less than the value obtained from Peirce's criterion, no observation should be discarded.

It may be worth noting here that the criterion proposed by Chauvenet for the rejection of a single doubtful observation, which gives results nearly the same as Peirce's criterion, also contains an obvious fallacy, and is of no value.

## THE TREATMENT OF DISCORDANT OBSERVATIONS.

By R. M. Stewart.

If the law of probability of error is

$$p = \frac{h}{\sqrt{\pi}} e^{-h^2 x^2}$$

it follows rigorously from the theory of probability that the arithmetic mean is the most probable value; that is, that all observations should have equal weight, and that no observations should be rejected. Consideration of the advisability of the rejection or weighting of observations therefore involves the assumption that the above law was not applicable to the series of observations considered. In fact, the assigning of weights by the observer to special observations is in itself a statement of his opinion that these particular observations did not follow the same law of error as the remainder.

From this conclusion it is not a far step to the assumption (which is, perhaps, obvious from other considerations) that seldom, if ever, is the precision of all observations in a series the same; that, in fact, each observation follows a law of the same form as the above, but that in the final analysis the value of $h$ is different for each observation: and that consequently the arithmetic mean is only a first approximation to the quantity sought.

That it is usually a very close approximation is shown by the fact that in most cases the actual distribution of errors approximates closely to the theoretical law; the tendency toward variability of $h$ is, however, indicated by the acknowledged average predominance of large errors, a predominance which is characteristic of the theoretical curve for observations of mixed precision.

In the case of discordant observations (that is, where the distribution of errors obviously does not follow closely the theoretical law), it would therefore appear to be the reasonable and legitimate process to proceed to a second approximation on the assumption of two distinct values of $h$. If $n_1$ observation of precision $h_1$ be mixed with $n_2$ observations of precision $h_2$ the resulting law of error will be

$$p = \frac{n_1}{n_1+n_2} \cdot \frac{h_1}{\sqrt{\pi}} e^{-h_1^2 x^2} + \frac{n_2}{n_1+n_2} \cdot \frac{h_2}{\sqrt{\pi}} e^{-h_2^2 x^2}$$

or putting

$$h_1 = H, \quad h_2 = \alpha H, \quad n_2 = \beta n_1$$

$$p = \frac{1}{1+\beta} \cdot \frac{H}{\sqrt{\pi}} \left[ e^{-H^2 x^2} + \alpha\beta e^{-H^2 \alpha^2 x^2} \right].$$

By the application of the usual laws of probability it may be easily shown that the most probable value of the observed quantity is

$$\frac{P_1 O_1 + P_2 O_2 + P_3 O_3 + \text{- - -}}{P_1 + P_2 + P_3 + \text{- - -}}$$

where in general

$$P = \frac{1 + \alpha^3 \beta e^{H^2 (1-\alpha^2) v^2}}{1 + \alpha \beta e^{H^2 (1-\alpha^2) v^2}};$$

that is, the most probable value is a weighted mean, the weights being a function of the residuals. If either $\alpha = 1$ or $\beta = 0$ this reduces to the ordinary case of the arithmetic mean.

$H$, $\alpha$ and $\beta$ are to be determined from the form of the curve, that is, from the residuals; the latter are given approximately by the first approximation, the arithmetic mean. It is proposed to determine two of the above quantities from a comparison of the simple sum of the residuals with the sum of their squares, and to eliminate the third by the assumption that $\alpha$ shall deviate as little as possible from unity.

We obtain easily

$$\epsilon^2 = \frac{[v^2]}{n-1} = \frac{\alpha^2 + \beta}{\alpha^2 (1+\beta)} \cdot \frac{1}{2H^2}$$

$$\eta = \frac{[v}{\sqrt{n(n-1)}} = \frac{\alpha + \beta}{\alpha(1+\beta)} \cdot \frac{1}{H\sqrt{\pi}}.$$

Hence

$$\frac{(\alpha^2+\beta)(1+\beta)}{(\alpha+\beta)^2} = \frac{2n}{\pi} \cdot \frac{[v^2]}{([v)^2} = M \text{ say.}$$

From the condition that $\alpha$ shall be a maximum we obtain from the last equation $\beta = \alpha$, giving

$$\frac{(1+\alpha)^2}{4\alpha} = M$$

from which the value of $\alpha$ is deduced.

The resulting simplified value of $P$ is

$$P = \frac{1 + \alpha^4 e^{\frac{1-\alpha^2}{2\alpha} \cdot \frac{v^2}{\epsilon^2}}}{1 + \alpha^2 e^{\frac{1-\alpha^2}{2\alpha} \cdot \frac{v^2}{\epsilon^2}}}.$$

To facilitate the operation, values of $P$ have been tabulated for various values of $M$ and $\frac{v}{\epsilon}$, so that the process of making the second ap-

proximation resolves itself into finding $M$ from the formula

$$M = \frac{2n}{\pi} \frac{[v^2]}{([v])^2}$$

and taking directly from the table the values of the weights of the individual observations. The new solution (the weighted mean) is then derived.

## TESTS OF DYES FOR RED AND INFRA-RED PHOTOGRAPHY.

By Florence J. Stocker.

The dyes which are used in sensitizing ordinary photographic plates to the green, red, and infra-red portions of the spectrum are of three general types, called respectively pinaverdol, pinacyanol, and dicyanin. The United States Bureau of Chemistry, Department of Agriculture, has been very successful in reproducing dyes of the pinaverdol and pinacyanol types. Several samples of each kind tested by the Bureau of Standards show that in sensitizing power Pv.I is somewhat superior to any German or English green sensitizer, and Pc.IX is practically the same as German pinacyanol and English sensitol red. These red sensitizers are iodides and have a tendency to flocculate badly in the staining bath. The American chemists, however, have gone a step farther in preparing red-sensitizing dyes, and have produced a chloride called Pc.XII which is very soluble, is twice as concentrated as the iodide, and does not flocculate in the water-alcohol-ammonia solution. These advantages are possessed in the same degree by a pinacyanol made by the Eastman Kodak Company, which is also a chloride, and gives a photo-sensitivity curve identical with that of Pc.XII. The Bureau of Chemistry has also produced several dicyanin dyes which are only slightly inferior to those of German make. They give a photographic maximum at wave-length 6900A instead of 7000A, and with a given exposure they sensitize some 500 angstroms less into the infra-red than Hoechst dicyanin does.

The Bureau of Chemistry has recently submitted for test a new type of dye, called kryptocyanin, of which sample K III 6 gives a very pronounced narrow region of photo-sensitivity from 7200A to 7700A. This may be of great importance for spectrum photography and for landscape photography.

## EXPERIMENTS WITH KAPTEYN'S METHOD FOR REDUCING GUIDING ERROR.

By Robert Trümpler and Frank Schlesinger.

The largest source of outstanding error in photographic work is guiding error due to imperfect following during the exposure. This affects faint and bright images in different degrees and gives rise to a kind of magnitude error. To obviate this in ordinary parallax work a rotating sector is now generally employed. This has proven effective in the case where it is desired to reduce the apparent magnitude of a single star. For the case in which it is desired to reduce to equality the images of many stars on the same plate, Kapteyn has proposed that the region be first photographed out of focus and the plate developed in the ordinary way; this is now used as a reducer plate on a subsequent evening. The plate is put back in the telescope in the same position it originally occupied and the region is photographed through it on a plate in the focal plane. The images on the latter will be approximately equal in intensity since the brighter the star the more is its light diminished by its correspondingly denser image on the reducer plate. Our experiments showed that good images could not be secured if the reducer is at any considerable distance from the focal plate, probably on account of diffraction scattering in the reducer images. Accordingly we designed a special plate holder in which the two films are held within two millimeters of each other. The reducer is of thin plate glass; it is exposed and used with the glass side out. Though used two millimeters out of focus it is taken 12 millimeters out of focus, and uniform images are secured by making the exposures only when the seeing is bad, and in addition by moving the images uniformly about a rectangular area defined by a set of special wires in the guiding eye-piece The method for developing the reducer plates is important, a standard degree of contrast being essential. We use rodinal in a five percent dilution, developing for four minutes in a temperature of + 20° C. It is also necessary to fix the ratio between the times of exposure for the reducer and the focal plates; for the work we have in hand we find this factor to be about five. When care has been taken to observe all essential precautions we find that the method just described will yield plates that give images of about the same intensity for all stars throughout a range of six or seven magnitudes.

The special plate holder already mentioned is so designed that both the reducer and the focal plate can be set back into their original positions at the telescope as often as we may wish. Thus images of the same stars may be secured side by side at various epochs if we desire to do so. In practice the method has been found to be very difficult

to carry out at the telescope, but there is no doubt that it is effective in greatly reducing the guiding error.

One of us has suggested a simple method with the same purpose in view, and has done some experimenting with it; this consists in exposing a plate in the ordinary way and then reducing the images to the same apparent brightness by the use of ferricyanide of potassium. The use of this particular reducing agent leaves the reduced image black and sharp, without turning it gray. Preliminary experiments show that the guiding error can be avoided in this way.

## MERIDIAN CIRCLE OBSERVATIONS OF NOVA AQUILAE NO. 3.

By R. H. Tucker.

Four observations of Nova Aquilae, recently made here, give the mean position for 1919.0

| Epoch | Mag. | R.A. 1919.0 | | | Dec. 1919.0 | | | Circle |
|---|---|---|---|---|---|---|---|---|
| | | h | m | s | ° | ′ | ″ | |
| 1919.61 | 6.7 | 18 | 44 | 46.580 | +0 | 29 | 34.16 | 4 West |

The right ascension has been corrected for my magnitude equation —0ˢ.008 per unit of magnitude. Four fundamental stars from the *American Ephemeris,* of mean magnitude 4.5, were employed in the reductions.

Following the appearance of the star as a brilliant naked eye object, last year, sixteen observations gave the following mean positions for 1918.0:

| Epoch | Mag. | R.A. 1918.0 | | | Dec. 1918.0 | | | Circle |
|---|---|---|---|---|---|---|---|---|
| | | h | m | s | ° | ′ | ″ | |
| 1918.57 | 2.6 | 18 | 44 | 43.516 | +0 | 29 | 30.17 | 8 West |
| 1918.57 | 3.6 | | | 43.539 | | | 30.07 | 8 East |
| | Precession | | + | 3.062 | | + | 3.89 | |

The same fundamental stars were employed in the reductions, for both years. The agreement of the results for the two years is close, especially if the observations made with fixed circle west be compared. Systematic differences, depending upon the position of the the instrument, are generally found to be negligible here; but differences of division errors affect the results in declination, in the two positions.

## THE USE OF SEMI-ABSOLUTE PHOTOGRAPHIC POSITIONS IN DOUBLE STAR ASTRONOMY.

By G. VAN BIESBROECK.

The accuracy with which bright stars can be referred to a number of faint comparison stars, considered as forming a fixed background, when using photographic plates taken with long-focus instruments, is far superior to the precision of meridian work and even to that of the highest class of micrometric measures. When due precautions are taken, such as the work of stellar parallaxes has shown to be sufficient, the semi-absolute positions of stars obtained that way are so free from personal or other systematic errors that their use opens new ways of attack in some problems of double-star astronomy.

During the regular work on stellar parallaxes at the Yerkes Observatory it was found that the available plates could often be used to advantage for this other purpose. Three examples are given as illustrations.

First, a direct mass-ratio determination in Castor. From plates covering three years (1916-1919) the proper motions were found:

| | | |
|---|---|---|
| Bright component, | $-0^s.0167$ | Equinox 1900.0 |
| Faint " | $-0.0118$ | |

According to Boss, the proper motion of the system, deduced from a long interval of time is $-0^s.0135$. The orbital motion during the three years considered is almost all in right ascension. The yearly motions relatively to the center of gravity of the system are consequently,

| | |
|---|---|
| Bright component | $-0.0032$ |
| Faint " | $+0.0017$, |

hence the mass ratio

$$\frac{\text{Faint component}}{\text{Bright component}} = \frac{0.0032}{0.0017} = 1.9.$$

The only previous determination of this ratio is the hypothetical value of 6.0 deduced by Curtiss from the measures of radial velocity of the two components, under the assumption that the spectroscopic binaries, of which each of these components consists, are moving in orbits equally inclined.

Another instance where photographic positions are to be preferred is that of very faint or invisible companions to bright stars, such as Procyon. Here only one component can be photographed. The companion has been followed visually during fourteen years only. Since the last measure in 1910, the distance has been closing in and very likely the companion will stay beyond the power of any instrument for another twenty years or nearly two-thirds of the whole period. Photographic positions will solve the difficulty. Prosecuted regularly for a number of years as they are started, these plates will give a homogeneous series of data, nearly free from systematic errors, covering the

period of invisibility of the companion as well as any part of the orbit with the same accuracy.

As a last illustration some preliminary results are presented about ζ Cancri. The absolute motion of the third companion, taken independently from the close pair, although followed only for a short interval of time, indicates already an anomaly in the sense of a rapid motion around an invisible fourth body in the system.

The results are only preliminary because a few years more are necessary before sufficiently accurate proper motions of the comparison stars can be obtained.

## NOTE ON THE PROPER MOTIONS OF CERTAIN LONG PERIOD VARIABLE STARS.

By Anne Sewell Young and Louise Freeland Jenkins.

The plates used in this investigation were selected from a series made with the 24-inch reflector of the Yerkes Observatory. The early plates were taken by Mr. Parkhurst and Mr. Jordan during the years 1902-08. These are being duplicated now at the Yerkes Observatory, the second plate being taken with hour-angle, aperture and exposure time the same as for the early one, the magnitude of the variable being as nearly the same as possible. These precautions seem to be necessary as the proper motions sought are evidently very small.

Before the plates are sent to us for measurement, each pair is examined in the stereo at Yerkes, so that any stars having large proper motion may be excluded from our list of standards and also so that the proper motions of such stars may be determined. Very few stars show any evident proper motion, but in the field of W Andromedae there are four showing century motions of 47″, 22″, 12″ and 7″; in the field of V Orionis there is one with a proper motion of 41″ per century.

The measures are made at the Observatory of Mount Holyoke College, using a measuring machine made for us by Mr. Gaertner in 1912. The variable is at or near the center of the plate; its position is compared with that of from 15 to 24 standard stars, so distributed that the sum of the $x$ and $y$ coördinates shall each be very nearly zero. These standards are usually within 8′ of the center and are as nearly equal to the variable in magnitude as is possible. The scale of the plates is 87″.4 to the millimeter.

We are not ready to give definitive results, but for nine of the best plates measured the average proper motion per century is 2″.0 in $x$, with a range from 0″.8 to 3″.3; in $y$ it is 1″.3 with a range from 0″.2 to 2″.2. The probable error of this century motion is about 0″.4 in each coördinate.

Larger values have been found in some other cases, but the plates are inferior and we do not place much confidence in the results. It has been our experience so far that the better the plates, the smaller the proper motion found.

## THREE SPECTROSCOPIC BINARY ORBITS.

By REYNOLD K. YOUNG.

The following spectroscopic binary orbits have been computed from plates taken with the one prism spectrograph attached to the 72-inch reflecting telescope.

### 1 GEMINORUM.

This star ( $\alpha$ 1900 $= 5^h\,58^m.0$, $\delta = +23^\circ\,16'$ ) was announced as a binary by Moore from the Lick Observatory in 1906. Four observations made there in 1903, 1905, 1906 suggested a very long period variation. It was placed on the observing program at the Dominion Observatory, Ottawa, in 1917 and since then 77 spectrograms have been obtained from which the present orbit has been determined. Twenty-six of these plates were made at Ottawa and the remaining 51 have been made here.

The determination of the orbital elements has proved rather troublesome. Not only is the total range of variation in the radial velocity small, but also besides this difficulty, which was to be expected, the early observations are difficult to reconcile with the ones taken in recent years. The period finally selected was 9.590 days which is the shortest yet found for a star of G type, exception being made for the Cepheid variables. The period harmonizes all the Victoria and Ottawa observations, also three plates taken at Bonn in 1909 and 1912, but it does not satisfy the Lick Observatory results. There are peculiarities in the motion of this system yet to be explained. Higher dispersion should be employed to trace these indicated irregularities to their source. In the meantime the following elements which are the result of a least squares solution from 12 normal places give a good approximation to the shape of the radial velocity curve in 1917 and 1918.

$$
\begin{aligned}
P &= 9.590 \text{ days} \\
e &= 0.2065 \quad \pm .03 \\
\omega &= 203^\circ \quad \pm 7^\circ \\
K &= 11.7 \text{ km} \quad \pm 0.3 \text{ km} \\
\gamma &= +19.7 \text{ km} \quad \pm 0.2 \text{ km} \\
T &= \text{J.D. } 2{,}421{,}898.741 \quad \pm 0.2 \text{ day} \\
a \sin i &= 1{,}510{,}000 \text{ km} \\
\frac{m_1^3 \sin^3 i}{(m+m_1)^2} &= .0015 \odot
\end{aligned}
$$

These elements represent the Victoria observations with a probable error for a single plate of 1.60 km and the Ottawa observations with a probable error of 3.00 km. They are suggestive of the spectroscopic elements of the Cepheid variables, inasmuch as the period is short, the eccentricity fairly high, the range in variation small and the orbit minute. On the other hand the star has not been observed to vary in brightness and accepting Adams' value for the parallax and luminosity,

$\pi = .052$, $L = 6.92$, the absolute magnitude equals $+ 2.82$. According to Shapley's curve in the *Publications of the Astronomical Society of the Pacific*, February 1918, for the Cepheid variable, a star of this period and magnitude should have an absolute magnitude of $-3.0$. The tentative conclusion one would be led back to is, that the star is not a Cepheid variable but a G type star with the shortest period yet found, but that the discrepancies in the early observations render it advisable to investigate the star further when higher dispersion is available.

Boss 4669.

This star ($\alpha$ 1900 $= 18^h\ 02^m.1$, $\delta = +29°\ 46'$, Vis. Mag. 5.71, type A2) was announced as a binary by the Mount Wilson Observatory in the *Publications of the Astronomical Society of the Pacific* **29**, 259. It was also independently discovered to have a variable radial velocity from four plates taken with the 72-inch reflector in 1918. The following orbit is the result of a least squares solution from 27 plates. The lines are beautifully sharp and narrow and the observations are represented with a probable error of 1.0 km. From 10 to 20 lines were measured on a plate. Attention is called to the rather unusually high value for the eccentricity.

| | |
|---|---|
| $P =$ 9.6120 days | $\pm$ .0004 day (estimated) |
| $e =$ 0.4684 | $\pm$ .0083 |
| $\omega =$ 326°.43 | $\pm$0°.83 |
| $T =$ J.D. 2,422,048.711 | $\pm$ .0110 day |
| $\gamma =$ 7.54 km | $\pm$0.23 km |
| $K =$ 28.49 km | $\pm$0.37 km |
| $a \sin i =$ 3,330,000 km | |
| $\frac{m_1^3 \sin^3 i}{(m + m_1)^2} =$ .016 $\odot$ | |

H.R. 8427.

This star ($\alpha$ 1900 $= 22^h\ 12^m.0$, $\delta = +47°\ 45'$, Vis. Mag. 6.16, type B3) was discovered to be a binary from four spectrograms made by the writer in 1918. The helium lines are broad and poorly defined and the calcium H and K lines very sharp and narrow. While the following elements are only preliminary they show that the star has all the well known characteristics of that peculiar class of star in which the calcium lines do not share at all or only partially in the shifting of the other lines.

$P =$ 2.1722 days
$e =$ 0 $\pm$
$K =$ 135 km
$\gamma =$ $-$25 km
Velocity for H and K lines $=$ $+$2 km
$T =$ J.D. 2,422,139.131

The component of the solar motion toward the star is approximately

— 13 km. In practically all the stars of this class so far investigated, the velocity of the H and K lines has yielded a velocity differing but little from the solar motion component. This has been taken by some as strengthening the view that the narrow calcium lines have their origin in some general or local cosmic calcium cloud. While some observations lend support to such a conclusion, yet the apparent agreement loses much of its significance when one considers the general low space velocity of the early type stars and the present example gives evidence that this apparent agreement is indeed only accidental.

## REPORTS OF COMMITTEES.

### REPORT OF THE CHAIRMAN OF THE COMMITTEE ON STELLAR PARALLAXES.

By FRANK SCHLESINGER, *Chairman.*

This committee has continued to keep its members informed of the progress of the work at the co-operating observatories; additions to the observing list, notes of stars abandoned and of stars whose observations have been completed, have been exchanged. The war has delayed the publication of the numerous parallax determinations that have been made during the past three or four years, but several of the observatories have prepared manuscript catalogues of their results and have distributed them to astronomers who were directly interested. It is hoped and expected that a good deal of this completed material may be in print before the next meeting of the Society.

At the organization meeting of the International Astronomical Union held at Brussels in July, 1919, a Committee on Stellar Parallaxes was formed. All the institutions in this country that are actively engaged in this work are represented in the membership of this international committee. The question will soon arise as to the desirability of continuing the committee of the American Astronomical Society after the International Committee has got well under way.

Allegheny Observatory.

### REPORT OF THE COMMITTEE ON METEORS.

By CHARLES P. OLIVIER, *Chairman.*

The committee desires to present the following report for the twenty-third meeting of the Society.

Practical work in meteoric astronomy may be divided roughly into two parts, first those problems that can be satisfactorily solved by methods now in use which do not require instrumental help, second those which require photography, used in connection with specially de-

vised instruments. Many problems of the first kind have of late years been fairly well taken care of by the American Meteor Society. At least definite progress has been made toward their solutions in some cases. Your committee desires to request all members of the American Astronomical Society to call the attention of amateurs to the desirability of helping out on these problems by joining the American Meteor Society. Also to suggest to teachers of astronomy, who assign practical work in their courses, that they have at least a few of the principal meteor showers observed by members of their classes, permanent records being kept. Interest in meteoric problems could be aroused in both of these very obvious ways.

Problems of the second kind can only be satisfactorily attempted by men trained in astronomy. It has been proved quite definitely that no human skill is great enough to settle some of the problems, using mere eye estimations of path and mental estimates of time. It cannot be urged too strongly that until instrumental means are employed for both these data, accurate orbits, heights of appearance and disappearance, real velocities, the laws of resistance in the upper atmosphere, etc., will never be obtained, except with rough approximation. It is well to emphasize this fact, since in text-books as well as in memoirs we find discussions of the orbits of meteors and meteorites, in which they are classified according to what conic section they belong to, as though the facts were certainly known. In many of these cases a change of only a tenth of a second of time would have totally changed the elements of the orbits. And in excessively few cases would any observer claim so great an accuracy in his estimation.

Such being the case, it is well to frankly admit we have little accurate knowledge about meteor orbits. Hence the need of better means of observing. The only instrument devised to date, so far as your committee knows, which would probably be satisfactory, is that invented by the late Prof. Cleveland Abbe. It is recommended that competent persons examine the drawings for the instrument, and if they prove acceptable, that two be made and placed at some regular observatory, in the hands of persons who will actually use them and report results. It will be necessary to secure the funds for their construction, but this difficulty could probably be overcome.

Finally it is suggested that closer co-operation between astronomers interested in cometary and asteroid problems, as well as meteorologists, and those interested in meteors, might be mutually beneficial.

As part of this report certain suggestions of Prof. E. E. Barnard are attached. In regard to these suggestions the request is made that persons engaged in comet seeking and variable star work, who have telescopes of the size needed, generally being used with low power, will keep them in mind and kindly report such observations to the headquarters of the American Meteor Society.

As an appendix to this report is added the annual report of the Amer-

ican Meteor Society for 1918, as a matter of information about the progress of meteoric astronomy in our hemisphere, during recent years.

The chairman has had communications relative to this report from the following members of the committee: Messrs. E. E. Barnard, W. J Humphreys, F. R. Moulton, W. H. Pickering.

## SUGGESTIONS FOR OBSERVING METEOR TRAINS.

By E. E. Barnard.

I would suggest that one thing that the meteor observer can do, which would be of very great value in the study of the meteorology of the upper atmosphere beyond the reach of ordinary means of research, is the observation of the direction of drift of the trains which are occasionally left by meteors. If one is supplied with a small wide-field telescope, such as is used by comet seekers, or with a field-glass, he will frequently find, if he turns instantly to the path of a bright meteor, that the train persists sometimes for minutes and can easily be observed. Chances of this kind are of frequent occurrence, especially during some of the well known meteor showers.

In my early comet seeking I gave much attention to this form of observation. A paper on the subject was printed in the Sidereal Messenger, Vol. I, p. 174, for November 1882. This was reprinted in Volume X, p. 426 of the same journal for October 1891. It is shown in the above paper that meteor trains drift easterly among the stars, indicating an easterly current in our atmosphere at great altitudes.

The path of any considerable meteor should be swept over at once with the telescope. The train will often be seen and may persist for some minutes. The direction and amount of motion of this train and its peculiarities should be noted.

## ANNUAL REPORT OF THE AMERICAN METEOR SOCIETY FOR 1918.

Due to the very unsettled condition of affairs in the United States during 1918, it was not thought wise nor proper that the members should be urged to work as much as usual, since most of them were people able to do various kinds of war work, and this had preference. Also it was impossible for the writer to attend to the business of the society as usual, since he was absent, from July until the end of the year, working for the War Department.

Despite these various handicaps a very fair number of observations were received, considering the circumstances. Ten members contributed in all 2050 observations. Especial mention is due Mr. Walter Pattison of Wilmette, Ill., who contributed 1104, or over half the total.

Considerable progress has been made by the writer in reducing the

observations for 1918, and the radiants have all been determined and measured at least once. Also for observations of 1917, which had not been worked up, progress has been made. If possible it is hoped to have the results of 1914-1918 inclusive completed and ready for publication within a year from this date. The numbers of observations sent in during these years were as follows:

| | |
|---|---|
| 1914 | 540 |
| 1915 | 5003 |
| 1916 | 10184 |
| 1917 | 4231 |
| 1918 | 2050 |
| Total | 22008 |

All these were made by persons working under a common system of directions and hence, though many had a part and the work is naturally very unequal in accuracy, yet there is a homogeneity about the whole never before secured in such a great mass of meteoric data. In the final publication full and proper credit will be given by name to all the observers whose unselfish work alone made the results possible.

CHAS. P. OLIVIER, President.

Leander McCormick Observatory, University of Virginia.

## REPORT OF THE COMMITTEE ON VARIABLE STAR OBSERVATIONS.

The original purpose of this committee was "the securing of variable star observations". That considerable progress along this line has been made there is little doubt. In the two previous reports of this committee, particular stress was laid on what had been accomplished and what it was hoped would be attained. Many of the suggestions there mentioned have been further developed and others still require attention.

The work of the American and British Variable Star Associations has been steadily increasing, so that now many of the long period, a few short period, and several irregular variables have been very thoroughly and carefully followed. This has been further aided by the efforts of variable star observers in the southern hemisphere, who are now following the southern stars almost as completely as the northern observers are covering the northern sky. The aid of several of the largest telescopes of this country has also proved of great help in giving us better determinations of the minima of the faint variables. With the revision and extension of the magnitudes of the fainter comparison stars this will prove still more helpful to the observer.

The benefits of close co-operation among variable star observers is well shown in the case of the recent bright Nova in Aquila. Results were obtained from 250 observers situated in nearly all parts of the world, and over 6000 observations were made during the first seven months after its apparition.

More efficient work has been accomplished by the American Association of Variable Star Observers through the efforts of that body to augment, where possible, the optical outfit of several of the more experienced observers. The grant received in 1918 from the American Association for the Advancement of Science has resulted most favorably and suggests a means for further aid by other societies. A 5-inch refractor has been purchased and placed in the hands of an observer who has been able to greatly enlarge his observing list as well as to secure observations at a much fainter stage.

There are two ways in which it would seem that the work of the committee might be extended, and which would prove helpful to all concerned:

First, a statement from the prominent observatories and experienced variable star observers, especially in this country, as to just what sort of work they are doing or contemplating in this line of research. By this means, unnecessary duplication could be avoided and neglected fields could be better attended to. There is much that can yet be done both photometrically and photographically on the short period and Algol variables.

Second, a canvass, in so far as is possible, of the available telescopes, say, of 4-inches aperture and greater, with a statement as to what work is now being carried on with them. As previously pointed out, there are doubtless many telescopes lying idle which could be put to practical use, if we could find an observer for the telescope, or the telescope for the observer.

The committee invites suggestions from the Society, especially those tending toward greater efficiency and co-ordination in variable star observing.

H. C. Bancroft, Jr.,
W. T. Olcott,
D. B. Pickering,
H. N. Russell,
Leon Campbell, *Chairman.*

## THE REFORM OF THE JULIAN CALENDAR.

ROSCOE LAMONT.

*(Continued from page 646, Vol. XXVII.)*

The Papal Bull was printed in 1582 in a small booklet of thirty leaves, which contained also the privilege of the Pope given to the printer; canons of the calendar treating of the lunar cycle of nineteen years, the solar cycle of twenty-eight years, the cycle of epacts, etc.; the calendar for 1582 from October to December. table giving the dates of the movable feasts for the year 1583, with the dominical letter, golden number and epact; table giving the dates of the new moons for October, November and December, 1582, and the whole of 1583, and some other tables. The sole right to print this work was given to Antonius Lilius, who had been a member of the papal commission and whose brother was the author of the plan adopted, and the Pope prohibited,under penalty of excommunication, the printing of the calendar by any one without permission. The result was that a sufficient number of copies was not printed and distributed so as to be received in all places in time to make the correction on the date indicated. In the greater part of Italy the change was made at the time directed, copies being printed in Venice, in Italian, marked "Permissu D. Antonii Lilii MDLXXXII." Spain and Portugal also made the change in October 1582. In the Catholic states of Germany and the Netherlands the reformed calendar was introduced by calling the day following December 21, 1582, January 1, 1583, those countries having no Christmas day in 1582. In France the day following Sunday, December 9, 1582, was called Monday, December 20, the edict of Henry Third being dated the third of November.

Sedan, now a province of France, but which in 1582 enjoyed what is called full sovereignty, although a hotbed of Calvinism, followed the example of France in adopting the new calendar. In the *Revue d'Ardenne et d'Argonne* for July 1897, Paul Collinet gives the following ordinance issued by the regent in 1582 on the fifth of December, which was published in the public places of the city at the sound of the trumpet on the eighth of the same month:

"Madame in her Council, having seen the reformation of the calendar which has been newly made, and wishing to be in accord with the princes and neighboring countries in the calculation of times and seasons for the facility of commerce, desires and directs that on the expiration of the ninth day of the present month, the day following, which would be counted the tenth, be named and counted the twentieth, the day after that the twenty-first, the fifteenth the twenty-fifth, and so on, so that the following year, which will be counted the fifteen hundred eighty-third, will begin on the twenty-second of the present month by the former reckoning. Said Madame declaring, however, that she does not intend that this omission shall be prejudicial to any actions, obligations, limitations of time, terms and

prescriptions, which she wishes to have their perfect course, notwithstanding the subtraction of the said days, the same as if it had not been made. Done in the said Council the fifth of December, 1582.

FRANCOISE DE BOURBON."

In the Catholic Encyclopedia, where one would expect to find accurate information about the Popes, it is stated in the life of Gregory XIII that the reformed calendar was introduced into most Catholic countries in 1578 (four years before its publication). The Protestant countries, however, after the time fixed for the acceptance of the New Style, as it was called, continued to use the Julian calendar as before, and actively opposed the adoption of the reform, a witticism of the time being that the Protestants would rather disagree with the sun than agree with the Pope. But religious disputes had been so bitter that anything emanating from Rome found no favor in the eyes of the Protestants. The massacre of Saint Bartholomew had occurred only ten years before, and it was recalled that the Pope then reigning had attended Church to hear the Te Deum sung in celebration of that event. The Protestants also disliked the language of the papal decree. When they read that the wrath of the omnipotent God and of His blessed Apostles Peter and Paul would be invoked on any one who refused to abandon a mode of reckoning that had been in use for more than sixteen hundred years, instead of the wrath being turned away with a soft answer, their own anger, like Moses', waxed hot. It is stated in Pfeffel's History of Germany that when the question of adopting the Gregorian calendar came up in the Diet of Augsburg in 1582, "the project, very reasonable in itself, would no doubt have been accepted without difficulty if the states had not been offended by the imperious and absolute tone with which the Pope had ordered them to follow his calendar. This circumstance, very foreign to the heart of the matter, excited at first discontent and general clamor against the proposal of the Pontiff. But the first resentment having been calmed by time and by reflection, the Princes and the Catholic States consented successively to receive the Gregorian style, but it was not the same with the Protestants, their aversion for anything coming from Rome determining them to hold invariably to the Julian calendar."

Nearly one hundred twenty years elapsed before the Protestant States of Germany accepted the new calendar, which they then camouflaged and called an "improved calendar". One province, however, received it a little in advance of the rest. About 1681 Alsace was conquered by Louis XIV, and the Gregorian calendar was introduced on March 1, 1682.

In Switzerland most of the Catholic Cantons adopted the New Style January 1, 1583, Unterwalden raising some objections and not accepting it until 1584. In Appenzell, where both Catholics and Protestants were numerous, the Gregorian calendar was adopted in 1584, but this action produced such violent disputes between the adherents of the two religions that civil war was feared. In 1590 the Canton was

divided, one part being Protestant and the other Catholic, and the Protestants restored the Julian calendar. In the other Cantons which contained followers of both parties an amicable arrangement was made. It was stipulated that the Protestants might keep their festivals according to the old calendar, and that on those days their Catholic brethren would cease their labors until noon, and that, reciprocally, the Catholics would celebrate their feasts according to the new calendar, and their Protestant friends were likewise to abstain from work until midday. Most of the Protestant Cantons adopted the new calendar January 12, 1701, but Appenzell continued for a long time afterward to make use of the calendar of Julius Caesar, and not until 1812 was the Gregorian calendar used throughout all of Switzerland.

The Registers of the Council of Geneva (the new capital of the world) contain the following with reference to the introduction of the Gregorian calendar into that place:

"In the name of God, Father, Son and Holy Spirit, Amen. Commencement of the eighteenth century. Wednesday, the day on which the eighteenth century commences, to be counted the twelfth of January, 1701, in consequence of the acceptance of the new calendar and of the publication that was made through all the city at the sound of the trumpet, some weeks ago, placarded and posted in all the crossroads in these terms: We make known to all persons that for the benefit and advantage of commerce and other good considerations, our Most Honored Seigniors have found it opportune to follow in future the new calendar after the example of most of the Princes and Protestant States, and in particular the Evangelical Cantons, their very dear allies and confederates, and that to effect this the month of January next will begin on the twelfth, the day after the last day of the present month of December being thus counted. Commanding all persons, public and private, to conform thereto, both in the city and in the lands of the Seigniory".

In the German histories of the Kalenderstreit, the word used by the Germans to denote the strife over the calendar, there are accounts of numerous pamphlets and poems that were published on the subject, and while the wit is for the most part witless, some of them, though a little coarse, are quite amusing. Some peasants, represented as discussing the matter, are unable to see the necessity for any change in a calendar according to which Christ was born. The old calendar must be the right one for the animals still use it. The stork flies away according to it, the bear comes out of his hole on the Candlemas day of the old calendar and not of the Pope's, and the cattle stand up in their stalls to honor the birth of the Lord on the Christmas night of the old and not of the new calendar. They also recognize in this work diabolical wickedness. The Pope was afraid the last day would come too quickly. He has made his new calendar so that Christ will get confused and not know when to come for the last judgment, and the Pope will be able to continue his knavery still longer. May Gott him punish.

This is not bad at all for a German, and the reason humorously given for the reform is equal to the one advanced seriously by a Tübingen professor named Osiander, in a work published in 1583, the character of which can be judged by samples. He declares they will have noth-

ing to do with a calendar made by the Pope, which was produced merely to sell, as indulgences were formerly sold, but as this trade has been broken up, he has replaced it with one that will pay better. Indulgences were sold only in certain specified years, but the calendar will be sold every year. He will probably order the starry heavens to go in accordance with it, and if astronomers should point out a disagreement, they will say at Rome it is not the Pope's fault, but that Joshua was the cause of this disorder by commanding the sun and moon to stand still; if he had let them alone and allowed them to continue their orderly course without interruption, the motions of the sun and moon would agree with the Gregorian calendar to a hair in each and every point.

Although the Protestants and some of the animals refused to make use of the Pope's calendar, inanimate objects were not so stubborn. A wonderful miracle was reported by an inquiring traveler. At Campolongo in Friuli, Italy, fourteen miles from Görz, there was a walnut tree which every year was bare until the night before Saint John's day, when suddenly leaves and blossoms were put forth, and little nuts appeared which ripened in due season. This had always happened on a fixed day of the old calendar, but the reformed calendar having been introduced in Friuli in October 1582, the miracle was performed in 1583 on the right day of the new calendar. The traveler reports that he hastened to the place to obtain branches from the tree and says: "I have today sent a branch, broken off on Saint John's day, to Herr von Dietrichstein, who no doubt will show it to the Kaiser." (At that time they had a Kaiser).

The Italian astronomer Riccioli, the most learned of all the opponents of Copernicus, states in his "Chronology Reformed and Reduced to Certain Conclusions," published in 1669, that a barren rod, which had been planted in a garden one Christmas eve, produced leaves, blossoms and fruit that same night, and that after the Gregorian correction the same thing occurred yearly on Christmas eve of the new calendar, and he says that when in Parma in the year 1629 he saw a branch from that tree sent from the Court of Vienna.

Although many of the learned men among the Protestants were opposed to the reformed calendar, there were two notable exceptions, Tycho Brahe and Kepler, the most famous astronomers of the time. Tycho set forth his opinion in his letters, the Latin text of two of which is given by Ferrari, and Dreyer, in his Life of Tycho Brahe, makes the following reference to this matter:

"With Johannes Major Tycho corresponded about the Gregorian reform of the calendar, which was promulgated in 1582, and ordered to be adopted by the Catholic world under threat of excommunication. In consequence of this, Protestants refused to make any alteration in the calendar. At Augsburg several members of the civic council had voted against the adoption of the new calendar for theological reasons, and when the mayor, in consequence, tried to arrest and carry off the principal theologian of Augsburg, the population rose in arms and set him free. When asked for his opinion, Tycho very sensibly remarks that if

the Pope at the time of Regiomontanus (that is, before the Reformation) had improved the calendar, Luther would most assuredly not have wished to interfere with it, as this matter had nothing to do with religious doctrines, and why should not the new calendar, approved of by the emperor, be accepted, as the Nicaean calendar-rules were still accepted even by Protestants?"

Kepler advocated the adoption of the reformed calendar in a work entitled "Dialogue on the Gregorian Calendar", published about 1612. This was not very favorably received, however, especially in the theological world, for Lersch, in his "Introduction to Chronology", states that when Kepler entered upon his duties in Linz he was not allowed to partake of the communion because of his calendar writings.

When the thirty years' war came to an end in 1648, an effort was made, though unsuccessful, to have the Gregorian calendar accepted by the Protestant States of Germany; but as the end of the century approached steps were taken, largely through the influence of Leibnitz, to make the change, and in the year 1700 what was styled "an improved calendar" was adopted. In that year the day following February 18 was called the first of March, but the date of Easter was to be determined by astronomical calculation instead of by the method explained by Clavius. It was declared that this act did not proceed from any condescension to the Roman Catholics, nor was it to be interpreted as an acceptance of the Gregorian calendar, as the omission of eleven days simply reduced the calculation of time to the course of the sun the same as it was before the Nicene Council, and the astronomical computation of Easter would be an annual and perpetual protest against the injunction of Pope Gregory.

Since the Catholics and Protestants used different methods in computing the date of Easter, they sometimes celebrated that festival on different dates. This occurred in 1724 when the Protestants celebrated Easter on April 9 and the Catholics on April 16, and in 1744 the Easter of the Protestants was on March 29 and that of the Catholics on April 5. This would also have happened in 1778, but as the Easter of the Protestants would come on the same day as the Jewish Passover, the Protestants preferred to agree with the Catholics rather than with the Jews. In 1774 the minister of the King of Prussia presented, in the name of his master, to the Diet of Ratisbonne a rescript stating that "His Prussian Majesty, foreseeing that in 1778 the Easter of the Protestants would not come on the same day as that of the Roman Catholics, and that it might occasion some trouble because it coincided with the Passover of the Jews, desired that the states of the empire take suitable measures in order that the two Christian communions should celebrate Easter on the same day, especially in the states where the two worships were equally authorized by law." The King declared that he had fixed the festival of Easter for the year 1778 on the nineteenth of April, instead of on the twelfth of April as calculated astronomically, in order not to celebrate it on the same day the Jews celebrated the Passover, the Jewish calendar placing their feast on April

12. In November 1774 the Diet unanimously declared that henceforth they would conform to the Gregorian calendar in fixing the date of Easter.

Until the time of Peter the Great, Russia, while using the Julian calendar, had not used the Christian Era, but had made use of the Era of Constantinople dating from the creation of the world. It was believed that the world was created on September 1, 5509 B. C., and therefore September 1, 1699, of the Julian Calendar was called in Russia the first day of the year 7208. But on December nineteenth and twentieth of that year decrees were issued by Peter the Great directing that the Christian Era be employed, and that the year begin on January 1 instead of September 1, the new order of things going into effect on the first of the following January, the event being marked by a celebration lasting for a week.

The Russians had come to expect big things of Peter the Great, but they were amazed to learn that even he could change the course of the sun. But not all approved the reform, for many believed that the age of the world had been diminished by hundreds of years, and the elderly Russians, who had grown old under the former system, met in secret to utter their protests. Voltaire, in his life of Peter the Great, says that some obstinate ones, persuaded that the world was created on the first of September, continued to begin the year at that time. The Czar was told that God would not have created the world in winter when the ground could not be cultivated, but in autumn when the corn and all the fruits were ripe, but Peter showed them with a globe that Russia was not the whole world, that in countries far to the south it was warm even in January, and that in the course of time the beginning of the year would be in different seasons since the tropical year was not the same length as the calendar year. It is supposed that the chief reason for not adopting the Gregorian calendar was the fact that England still refused to accept it, and in Russia, previous to the revolution of 1917, the Julian calendar continued to be used. A dispatch from Russia published in the New York Times December 27, 1917, stated that arrangements had been made by the Bolsheviki to introduce the Gregorian calendar in the early part of 1918 by the omission of thirteen days, the day following December 24, 1917, to be called January 7, 1918, Russia by this omission losing the intervening Christmas and New Year's day.

The decree of Peter the Great dated December 19, $\frac{7208}{1699}$, is entitled: "An Edict of His Imperial Majesty. On the writing henceforth in all papers from the first of January, 1700, since the birth of our Lord, but not since the creation of the world."

The decree of December 20 was one long to be remembered, and an English translation of it, made from the Russian by Mrs. Derman of the Library of Congress, is given as follows:

"December 20, 7208. An Edict of His Imperial Majesty. On the Celebration of the New Year.

"The Grand Emperor ordered to tell: He, the Grand Emperor, is aware that not only in many European Christian countries, but amongst the Slavonian peoples also, which in everything are in conformity with our Eastern Orthodox Church, as for instance, amongst the Wallachians, Moldavians, Serbs, Dalmatians, Bulgarians, and the very subjects of the Grand Emperor, the Cherkesses and Greeks, from whom we have embraced our orthodox religion, that all those peoples are counting in conformity their years from the birth of our Lord—eight days later, that is, from the first of January, but not from the creation of the world on account of the many differences in the reckoning of those years. And at present the year 1699 since the birth of our Lord is approaching its end, and on the first of the coming January will conjointly begin the new year of 1700 and the new century.* And for the sake of that good and useful cause, the Grand Emperor has decreed to count henceforth in the Government departments, and in all affairs and deeds to write from the first of this January the year 1700 since the birth of our Lord. And as a token of this good undertaking and of the new century, in the royal city of Moscow, after due thanksgiving to God and supplicant chantings in a church, and, if need, at one's home, by people of distinction on the large and notable streets, thoroughfares and at the houses of the eminent men of clergy and of worldly rank, there should be made opposite the gates, in front of the images of saints, some ornaments of trees and of pine, fir and juniper branches, like those prepared on the bazaar and at the lower drug store, or they may be made as it is more convenient and proper for anyone according to the gates and the place; but everyone of the poor people shall at least place a tree or a branch on the gate or over his house, and it ought to be ready toward the first of the coming January of that year, and the ornaments must be in their places until the seventh day of January of the year 1700. Furthermore, on the first day of January, as a token of merriment, on the mutual greetings of the New Year and of the new century, there should be done the following: As soon as on the Great Red Square the fire amusements are kindled and a cannonade begins, on the notable courtyards the Boyars and Okolnichies, and the Counsellors and the high and distinguished persons of the Court, military and merchants' ranks, everyone on his courtyard, should produce three times a cannonade from small cannons, if they are at one's disposal, and from several muskets or some other kind of small rifles, and shoot rockets, as many as one may have, and on the large streets where there is a space, from the first to the seventh of January should be kindled in the night time fires of firewood, dry branches and straw, but where the courtyards are small, five or six courtyards should be joined in order to make such a fire, or, if one would like, he should place on poles, by one, two or three, resinous and worn out barrels, and after filling them with straw or dry branches, to kindle them; and before the town hall of the burgomaster the cannonade and the same firing and ornaments should be arranged at his discretion."

Soon after the publication of the Gregorian calendar in 1582 the Patriarch of Constantinople promised to have it adopted by the Greeks, but having been accused before the Turks of making an agreement with the Pope and Christian Princes, he was deposed and imprisoned, and the Greeks continued to use the Julian calendar and perhaps still use it.

The year 1700 was a leap year by the Julian calendar but not by the Gregorian, and therefore March 1, 1700, Julian, corresponded to March 12, 1700, Gregorian, the difference then amounting to eleven days. Sweden, however, decided to stay just ten days behind, the same as she had been for over a hundred years, and therefore made

*Most people would say that the year 1701 was the first year of the eighteenth century, but what the Czar decreed was law in his dominions, for he said he had only two lawyers and intended to hang one of them.

the year 1700 a common year. The years 1704 and 1708 were leap years, and in 1712, also a leap year, another day was added to February to compensate for the one omitted in 1700, thus giving 367 days to the year 1712, February having thirty days. The extra day was added in February so that Easter would be celebrated on the Sunday designated by the Julian calendar-rules, it having been found that in 1705, 1709 and 1711, Easter day as observed in Sweden fell one week before the day observed in England where the Julian calendar was used, and this would have happened again in 1712 if another day had not been added. This was due to the fact that the Julian calendar-rules for finding the date of Easter were retained by Sweden. The fourteenth day of the moon on which Easter depended came in 1705, 1709 and 1711, on Sunday, April 1, April 17 and March 25, respectively, of the Julian calendar, and Easter was therefore celebrated on the following Sunday, April 8, April 24 and April 1. But in these years April 1, April 17 and March 25 came on Saturday in Sweden, and Easter by the rule was celebrated the next day, April 2, April 18 and March 26.

From March 1, 1700, to February 30, 1712, Sweden had a calendar unlike any other, it being one day in advance of the Julian and ten days behind the Gregorian. But beginning March 1, 1712, the Julian calendar was again used and continued to be used until 1753. By a rescript dated February 24, 1752, the omission of eleven days was ordered in the next year, the day following February 17, 1753, being called March 1. Previous to this, however, a change was made in the manner of calculating the time of Easter. In 1739 the astronomical method of determining this date was adopted (as used by the Germans with their "improved calendar"), and this was not abandoned until 1844*.

An attempt was made to have the Gregorian calendar adopted by England during the reign of Queen Elizabeth. On March 16, 1584, (the year beginning on March 25) a bill was introduced into Parliament entitled, "An act giving Her Majesty authority to alter and new make a calendar according to the calendar used in other countries", but no action was taken in the matter, and England, not inclined to change anything firmly established, preferred to go on with the old calendar, especially as the alternative was to accept one prepared by direction of the Pope.

In the seventeenth century a plan was formed to adopt the New Style by suppressing the intercalary day in leap year until a sufficient number of days had been dropped, instead of by omitting them all at one time. John Wallis, Professor of Geometry at Oxford, and a noted

*Ginzel, Handbook of Chronology, Vol. 3, page 275. Ginzel's account of the adoption of the New Style by Sweden is entirely different from that given by Bond in his Handy Book of Verifying Dates, by Montucla in his History of Mathematics, and by the Britannica, no two of these agreeing. Ginzel's account is based on the works of Goldscheider (1898) and Lindhagen (1909).

mathematician, made the following objection to this procedure:

"In the time of Julius Caesar and Augustus Caesar there was a year which was called annus confusionis: upon the settling, unsettling and resettling the Julian year. But if this advice should take place, we should now, instead of one annus confusionis, have a confusion for four and forty years together wherein we should agree neither with the old nor with the new account, but be sometimes ten days, sometimes nine days, sometimes eight days, etc., later than the one and sooner than the other account, and a foreigner would not be able to judge of an English date without knowing in which of these years we varied ten, nine or eight days from either of these accounts."

Wallis also in 1699 gave his views on the Gregorian calendar in general, and it was chiefly due to his opposition that the change was not made at that time when the question was under consideration in Germany, Denmark and Sweden, his opinion being as follows:

"That the Julian year is in itself a better form and more advisable than the new Gregorian is undeniable, and all astronomers, even papists themselves (if not otherwise bigoted in favor of the Pope's supremacy and the infallibility of the Roman Church) cannot but know it; in so much that in many cases they are fain (or find it advisable) first to adjust their calculations to the Julian year and thence transfer them to the Gregorian. And there is no inducement for our changing our better year for a worse, but only in compliance with the Pope's pretended supremacy, not only over all churches and kingdoms, but even the celestial motions (as Pope Gregory, in his Bull, doth wisely pretend)."

At last, however, Lord Chesterfield took up the matter, and with the aid of Lord Macclesfield, afterwards President of the Royal Society, and James Bradley, astronomer royal, prepared a bill which was introduced into Parliament of February 25, 1750/51 (1751 with the year beginning January 1). The bill was passed without a dissenting vote and received the king's approval on May 22. By this Act the commencement of the year in England was changed to January first, the year 1752 beginning on that date. Since 1155 the year in England had begun on March 25, but in Scotland the change to January 1 was made in the year 1600. By the same Act of Parliament eleven days were omitted in September 1752, the day following the second being called the fourteenth, the English dates then coming into agreement with those of most of the other countries of Europe.

The reason for selecting this date for the beginning of the New Style is nowhere stated, but as September 14 was the day on which the papal commission, nearly two centuries before, made its report to Pope Gregory, it may be that England, after this long interval, wished to commemorate this date, and therefore made it notable as the day on which she began to make use of the Pope's calendar.

Lord Chesterfield, in a letter to his son dated March 18, 1750/51, gives a very interesting as well as amusing account of his work in connection with the reform, from which the following is quoted:

"I acquainted you in a former letter that I had brought a bill into the House of Lords for correcting and reforming our present calendar, which is the Julian, and for adopting the Gregorian. I will now give you a more particular account of that affair, from which reflections will naturally occur to you that I hope may

be useful, and which I fear you have not made. It was notorious that the Julian calendar was erroneous and had overcharged the solar year with eleven days. Pope Gregory XIII corrected this error. His reformed calendar was immediately received by all the Catholic powers of Europe, and afterwards adopted by all the Protestant ones except Russia, Sweden and England. It was not in my opinion very honorable for England to remain in a gross and avowed error, especially in such company. The inconvenience of it was likewise felt by all those who had foreign correspondences, whether political or mercantile. I determined, therefore, to attempt the reformation. I consulted the best lawyers and the most skillful astronomers, and we cooked up a bill for that purpose. But then my difficulty began. I was to bring in this bill, which was necessarily composed of law jargon and astronomical calculations, to both of which I am an utter stranger. However, it was absolutely necessary to make the House of Lords think that I knew something of the matter, and also to make them believe that they knew something of it themselves, which they do not. For my own part I might just as soon have talked Celtic or Slavonian to them as astronomy and they would have understood me full as well. So I resolved to do better than speak to the purpose, and to please instead of informing them. I gave them, therefore, only an historical account of calendars from the Egyptian down to the Gregorian, amusing them now and then with little episodes; but I was particularly attentive to the choice of my words, to the harmony and roundness of my periods, to my elocution, to my action. This succeeded and ever will succeed. They thought I informed because I pleased them, and many of them said that I had made the whole very clear to them when, God knows, I had not even attempted it. Lord Macclesfield, who had the greatest share in forming the bill, and who is one of the greatest astronomers and mathematicians in Europe, spoke afterwards with infinite knowledge and all the clearness that so intricate a matter would admit of; but as his words, his periods and his utterance were not near so good as mine, the preference was most unanimously, though most unjustly, given to me."

Although the bill encountered no opposition in Parliament, the people as a whole were far from unanimous in approving it. Lecky, in his History of England in the Eighteenth Century, says:

"A widespread irritation was for a time aroused. Much was said about the profanity of altering saint-days and immovable feasts. At the next election, one of the most popular cries against Lord Macclesfield's son was: 'Give us back our eleven days'. When, many years later, Mr. Bradley died of a lingering disease, his sufferings were supposed by the populace to be a judgment due to the part he had taken in the transaction."

In Hogarth's picture of "An Election Entertainment", published in 1755, the followers of one of the candidates are having a glorious celebration, and one of the banners bears the inscription: "Give us our eleven days."

A political ballad of the time began:

In seventeen hundred and fifty-three
The style it was changed to Popery,
But that it is liked we don't all agree,
Which nobody can deny.

When the country folk first heard of this act,
That old Father Time was condemned to be racked
And robbed of his style, which appears to be fact
Which nobody can deny;

It puzzled their brains, their senses perplexed,
And all the old ladies were very much vexed,
Not dreaming that Levites would alter our text,
Which nobody can deny.

In the first line, in order to make a rhyme, the poet has given the wrong year, poetic lie-cense. Another verse ran:

> What a whimsical change will be wrought in our isle
> By this odd fangled leap-frog of old and new style.
> Time hastens his pace, in his boundless career,
> To add to the jokes of this marvelous year,
> When from Britons eleven broad days took their flight,
> And, waking, all swore they had slept but one night.

As the Act introducing the New Style into England also effected the change in this country it is of considerable interest, and a portion of it is quoted as follows:

"An Act for regulating the Commencement of the Year, and for correcting the Calendar now in use.

"Whereas the legal supputation of the year of our Lord in that part of Great Britain called England, according to which the the year beginneth on the 25th day of March, hath been found by experience to be attended with divers inconveniences, not only as it differs from the usage of neighboring nations, but also from the legal method of computation in that part of Great Britain called Scotland, and from the common usage throughout the whole kingdom, and thereby frequent mistakes are occasioned in dates of deeds and other writings, and disputes arise therefrom; and whereas the calendar now in use throughout all His Majesty's British dominions, commonly called the Julian calendar, hath been discovered to be erroneous, by means whereof the vernal or spring equinox, which at the time of the General Council of Nice in the year of our Lord 325, happened on or about the 21st day of March, now happens on the ninth or tenth of the same month. . . . . And whereas a method of correcting the calendar in such manner as that the equinoxes and solstices may for the future fall nearly on the same nominal days on which the same happened at the time of said general council, hath been received and established, and is now generally practiced by almost all other nations of Europe; and whereas it will be of general convenience to merchants and other persons corresponding with other nations and countries, and tend to prevent mistakes and disputes in or concerning the dates of letters and accounts, if the like correction be received and established in His Majesty's dominions. May it therefore please your Majesty that it may be enacted, and be it enacted by the king's most excellent majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons in this present Parliament assembled, and by the authority of the same, that in and throughout all His Majesty's dominions and countries in Europe, Asia, Africa and America, belonging or subject to the crown of Great Britain, the said supputation, according to which the year of our Lord beginneth on the 25th day of March, shall not be made use of from and after the said day of December 1751; and that the 1st day of January next following the said last day of December shall be reckoned, taken, deemed and accounted to be the first day of the year of our Lord 1752. . . . . and that from and after the said 1st day of January, 1752, the several days of each month shall go on, and be reckoned and numbered in the same order; and the feast of Easter, and other movable feasts thereon depending, shall be ascertained according to the same method as they now are, until the 2nd day of September in the said year 1752, inclusive; and that the natural day next immediately following the said 2nd day of September, shall be called, reckoned and accounted to be the 14th day of September, omitting for that time only the eleven intermediate nominal days of the common calendar. . . . .

2. And for the continuing and preserving the calendar or method of reckoning, and computing the days of the year in the same regular course, as near as may be, in all times coming; be it further enacted by the authority aforesaid; that the several years of our Lord 1800, 1900, 2100, 2200, 2300, or any other hundredth years of our Lord, which shall happen in time to come except only every fourth hundredth year of our Lord, whereof the year of our Lord 2000 shall be the first, shall not be esteemed or taken to be bissextile or leap years, but shall be taken to be common years, consisting of 365 days and no more; and that the

years of our Lord 2000,2400,2800, and every other fourth hundredth year of our Lord, from the said year of our Lord 2000 inclusive, and also all other years of our Lord, which by the present supputation are esteemed to be bissextile or leap years, shall for the future and in all times to come be esteemed and taken to be bissextile or leap years, consisting of 366 days, in the same sort and manner as is now used with respect to every fourth year of our Lord."

De Morgan, in his History of the Ecclesiastical Calendar, speaking of this Act of Parliament, says:

"The Roman Church published a full and correct, if not a clear, account of the reasons which induced it to construct the particular calendar on which we are writing, and of the mode of proceeding. The British Parliament added nothing to the extracts which it gave from the Roman rules, except the following sentence of explanation: 'Easter day, on which the rest depend, is always the first Sunday after the full moon which happens upon, or next after, the 21st day of March, and if the full moon happens upon a Sunday, Easter day is the Sunday after.' But the Parliament either forgot, or did not know, that the bright round or horned body which shines in the heavens, which people call the moon, and which centainly is the moon, neither is, nor ever was, nor (since 1582) was intended to be, nor was asserted to be, the moon of the calendar. On the contrary, all reasonable trouble was taken to make it clear that the moon of the Gregorian calendar was a creation of the Church, which, though allowed to maintain certain relations with the moon of the heavens, was in every particular contrived to suit the convenience of those who invented it. Again, the British Parliament, in common with most astronomers, and many modern writers on the calendar, was not aware that it was not the full moon even of the fictitious moon from which Easter was determined, but the fourteenth day from the day of the new moon inclusive, which was always one day, sometimes two days, before the full moon. . . . . It was decidedly clumsy to take the Pope's calendar, and disguise it by stating it to depend on a moon which contradicts it. The man who stole the saucepan and put on a new lid that the owner might not be able to swear to it, took care the new lid should fit."

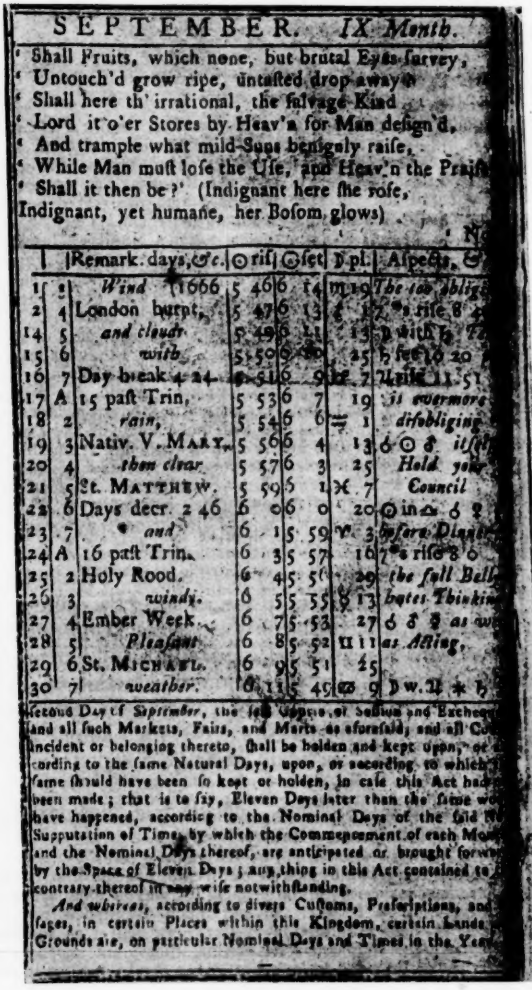
In Poor Richard's almanac for 1752 Benjamin Franklin published the Act in full,.and in his address to the reader gave quite a complete history of the calendar, concluding in this way: "This Act of Parliament, as it contains many matters of importance, and extends expressly to all the British colonies, I shall, for the satisfaction of the publick, give at full length: Wishing withal, according to ancient custom, that this New Year, (which is indeed a New Year, such an one as we never saw before, and shall never see again) may be a happy year to all my kind readers."

In Poor Job's almanac for 1752, published at Newport by James Franklin, brother of Benjamin, Poor Job says:

"We are not to have two beginnings to our years, but the first of January is to be the first day and first month of the year 1752; eleven days are taken from September, and begin 1, 2, 14, 15, etc. Be not much astonished, nor look with concern, dear reader, at such a deduction of days, nor regret as for the loss of so much time; but take this for your consolation, that your expenses will perhaps appear lighter and your mind be more at ease. And what an indulgence is here for those who love their pillows, to lie down in peace on the second of this month, and not perhaps awake, or be disturbed, till the fourteenth in the morning."

Two pages of Benjamin Franklin's almanac for 1752, containing the month of September, are shown in facsimile, that month having but nineteen days, the fourteenth following the second. Before the adoption of the New Style the almanac began with January marked as

the eleventh month. The beginning of the legal year was then March 25, but January 1 was considered as the beginning of the historic year, as Franklin explains in his history of the calendar. For dates between



SEPTEMBER. *IX Month.*

' Shall Fruits, which none, but brutal Eyes survey,
' Untouch'd grow ripe, untaſted drop away?
' Shall here th' irrational, the ſalvage Kind
' Lord it o'er Stores by Heav'n for Man deſign'd,
' And trample what mild Suns benignly raiſe,
' While Man muſt loſe the Uſe, and Heav'n the Praiſe?
' Shall it then be?' (Indignant here ſhe roſe,
Indignant, yet humane, her Boſom glows)

| | | Remark. days, &c. | ☉ riſ. | ☉ ſet | D. pl. | Aſpects, &c. |
|---|---|---|---|---|---|---|
| 1 | 2 | *Wind* (1666 | 5 46 | 6 14 | ♏ 19 | *The too obliging* |
| 2 | 4 | London burnt, | 5 47 | 6 13 | ♐ 17 | ☽ rise 8 4 |
| 14 | 5 | *and clouds* | 5 49 | 6 11 | ♐ 13 | ☽ with ♄ 12 |
| 15 | 6 | *with* | 5 50 | 6 10 | ♐ 25 | ♄ set 10 20 |
| 16 | 7 | Day break 4 24 | 5 51 | 6 9 | ♑ 7 | ☽ rise 11 51 |
| 17 | A | 15 paſt Trin. | 5 53 | 6 7 | ♑ 19 | *it evermore* |
| 18 | 2 | *rain,* | 5 54 | 6 6 | ♒ 1 | *diſobliging* |
| 19 | 3 | Nativ. V. MARY. | 5 56 | 6 4 | ♒ 13 | ☽ ☌ ♂ *it ſtill* |
| 20 | 4 | *then clear* | 5 57 | 6 3 | ♒ 25 | *Hold your* |
| 21 | 5 | St. MATTHEW. | 5 59 | 6 1 | ♓ 7 | *Council* |
| 22 | 6 | Days decr. 2 46 | 6 0 | 6 0 | ♓ 20 | ☉ in ♎ ☽ ☍ ♀ |
| 23 | 7 | ☽ *and* | 6 1 | 5 59 | ♈ 3 | *before Dinner* |
| 24 | A | 16 paſt Trin. | 6 3 | 5 57 | ♈ 16 | ☽ ☍ ☉ rise 8 0 |
| 25 | 2 | Holy Rood. | 6 4 | 5 56 | ♈ 29 | *the full Bell* |
| 26 | 3 | *windy.* | 6 5 | 5 55 | ♉ 13 | *bates Thinking* |
| 27 | 4 | Ember Week | 6 7 | 5 53 | ♉ 27 | ☽ ☌ ☿ *as we* |
| 28 | 5 | *Pleaſant* | 6 8 | 5 52 | ♊ 11 | *as Aſſing,* |
| 29 | 6 | St. MICHAEL. | 6 9 | 5 51 | ♊ 25 | |
| 30 | 7 | *weather.* | 6 11 | 5 49 | ♋ 9 | ☽ ☍ ☿ ✶ ♄ |

Second Day of *September*, the ſaid Courts of Seſſion and Exchequer and all ſuch Markets, Fairs, and Marts as aforeſaid, and all Cuſtoms incident or belonging thereto, ſhall be holden and kept upon, or according to the ſame Natural Days, upon, or according to which the ſame ſhould have been ſo kept or holden, in caſe this Act had not been made; that is to ſay, Eleven Days later than the ſame would have happened, according to the Nominal Days of the ſaid New Supputation of Time, by which the Commencement of each Month and the Nominal Days thereof, are anticipated or brought forwards by the Space of Eleven Days; any thing in this Act contained to the contrary thereof in any wiſe notwithſtanding.

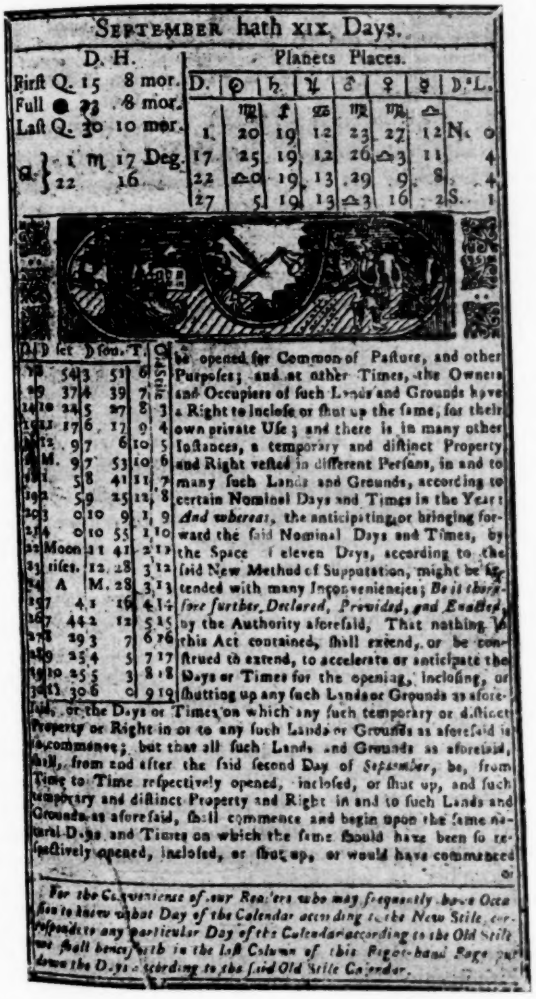
*And whereas*, according to divers Cuſtoms, Preſcriptions, and Uſages, in certain Places within this Kingdom, certain Lands, Tenements, Grounds are, on particular Nominal Days and Times in the Year

FACSIMILE PAGE OF BENJAMIN FRANKLIN'S ALMANAC FOR 1752.

January 1 and March 25, it was customary to write first the year whose beginning was March 25, followed by the corresponding year which began January 1. In the Washington Bible at Mount Vernon the record of Washington's birth is: George Washington was born the

eleventh day of February, 1731/2. A facsimile of this entry may be seen in Woodrow Wilson's Life of Washington.

Mistakes are frequently made by writers who fail to take into con-



SEPTEMBER hath XIX Days.

D. H.

First Q. 15 8 mor.
Full ● 23 8 mor.
Last Q. 30 10 mor.

☊ ☌ ♄ ♃ ♂ ♀ ☿ D.ºL.

1 Deg. 17 16

Planets Places.

| D. | ☽ | ♄ | ♃ | ♂ | ♀ | ☿ | D.ºL. |
|---|---|---|---|---|---|---|---|
| | ♍ | ♐ | ♓ | ♍ | ♍ | ♎ | |
| 1. | 20 | 19 | 12 | 23 | 27 | 12 | N. 0 |
| 17 | 25 | 19 | 12 | 26 | ♎3 | 11 | 4 |
| 22 | ♎0 | 19 | 13 | 29 | 9 | 8 | 4 |
| 27 | 5 | 19 | 13 | ♎3 | 16 | 2 | S. 1 |

D. | ☽ let | ☽ fou. | T. | ☊ | Sig.

| | | | | | |
|---|---|---|---|---|---|
| 18 | 5 | 43 | 51 | 6 | |
| 19 | 3 | 17 | 4 | 39 | 7 |
| 14 | 10 | 24 | 5 | 27 | 8 |
| 15 | 22 | 17 | 6 | 17 | 9 |
| 16 | 12 | 9 | 7 | 6 | 10 |
| 17 | M. | 9 | 7 | 53 | 10 |
| 18 | 1 | 5 | 8 | 41 | 11 |
| 19 | 2 | 5 | 9 | 25 | 12 |
| 20 | 3 | 0 | 10 | 9 | 1 |
| 21 | 4 | 0 | 10 | 55 | 1 |
| 22 | Moon | | 11 | 41 | 2 |
| 23 | rifes. | | 12 | 28 | 3 |
| 24 | A | M. | 28 | | 3 |
| 25 | 7 | 4 | 1 | 16 | 4 |
| 26 | 7 | 44 | 2 | 12 | 5 |
| 27 | 8 | 29 | 3 | 7 | 6 |
| 28 | 9 | 25 | 4 | 5 | 7 |
| 29 | 10 | 25 | 5 | 3 | 8 |
| 30 | 13 | 30 | 6 | 0 | 9 |

be opened for Common of Pasture, and other Purposes; and at other Times, the Owners and Occupiers of such Lands and Grounds have a Right to inclose or shut up the same, for their own private Use; and there is in many other Instances, a temporary and distinct Property and Right vested in different Persons, in and to many such Lands and Grounds, according to certain Nominal Days and Times in the Year: *And whereas*, the anticipating or bringing forward the said Nominal Days and Times, by the Space of eleven Days, according to the said New Method of Supputation, might be extended with many Inconveniencies; *Be it therefore further Declared, Provided, and Enacted*, by the Authority aforesaid, That nothing in this Act contained, shall extend, or be construed to extend, to accelerate or anticipate the Days or Times for the opening, inclosing, or shutting up any such Lands or Grounds as aforesaid, or the Days or Times on which any such temporary or distinct Property or Right in or to any such Lands or Grounds as aforesaid is to commence; but that all such Lands and Grounds as aforesaid, shall, from and after the said second Day of *September*, be, from Time to Time respectively opened, inclosed, or shut up, and such temporary and distinct Property and Right in and to such Lands and Grounds as aforesaid, shall commence and begin upon the same natural Days and Times on which the same should have been so respectively opened, inclosed, or shut up, or would have commenced or

*For the Convenience of our Readers who may frequently have Occasion to know what Day of the Calendar according to the New Stile, corresponds to any particular Day of the Calendar according to the Old Stile we shall henceforth in the last Column of this Page on the right Hand Page set down the Days according to the said Old Stile Calendar.*

FACSIMILE PAGE OF BENJAMIN FRANKLIN'S ALMANAC FOR 1752.

sideration the difference between the Julian and Gregorian calendars, and mistakes are sometimes made when this difference is taken into account, but in the wrong way. Richard Henry Dana, in his "Two

Years before the Mast", says that in 1835 he was on the coast of California, and the following statement is made:

"Friday, December 25. This day was Christmas, and as it rained all day long, and there were no hides to take in, and nothing especial to do, the Captain gave us a holiday (the first we had had, except Sundays, since leaving Boston), and plum-duff for dinner. The Russian brig, following the Old Style, had celebrated their Christmas eleven days before, when they had a grand blow out, and (as our men said) drank, in the forcastle, a barrel of gin, ate up a bag of tallow, and made a soup of the skin."

There is no possibility of this statement being true as to the time of the Russian sailors celebrating Christmas. In 1855 there was a difference between Old Style and New Style of twelve days instead of eleven, and the Russians would have celebrated their Christmas twelve days *after* the Americans celebrated theirs instead of eleven days *before* as Dana says.

Benjamin Franklin said in Poor Richard that people make mistakes every day for want of minding the almanac.

Victor Hugo, in his book on Shakespeare, says that "April 23, 1616, the same day, almost at the same minute, Shakespeare and Cervantes died. Why were these two flames blown out at the same moment? No apparent reason. A whirlwind in the night."

Cervantes died in Spain April 23, 1616, and Spain was at that time using the Gregorian calendar. Shakespeare died in England April 23, 1616, and England was then using the Julian calendar. The difference between the two calendars was ten days, and therefore when Shakespeare died Cervantes had been dead for ten days. A mistake by Victor Hugo for want of minding the almanac.

The date of the landing of the Pilgrim Fathers was December 11, 1620, Old Style, and as there was then a difference of ten days between the Old and the new Style, this date would have been written, in a country which used the Gregorian calendar, as December 21. In 1769 the Old Colony Club of Plymouth inaugurated the celebration of Forefathers' Day, and as the New Style had been adopted a few years before, they wished to celebrate the landing of the Pilgrims in the very latest style. At that time the difference between the two styles amounted to eleven days, due to the fact that the year 1700 was not a leap year according to the Gregorian calendar, and they therefore, in order to make the change, moved the date forward eleven days and celebrated December 22, which was not in accordance with any style at all, old or new, as an advance of but ten days should have been made giving the correct date December 21. This mistake was pointed out by James Thacher in his History of Plymouth published in 1832.

In Moliere's comedy, "The Shopkeeper turned Gentleman," Mr. Jourdain requests his professor to teach him, not philosophy but the almanac. Writers nowadays ought to follow the example of Mr. Jourdain and include the almanac in their course of studies.

Washington, D. C.

*(To be Continued.)*

# FIRST STUDY OF HEAVENLY BODIES.

By MARY E. BYRD.

## LESSON I.

It is a pleasant memory that has staid with me for years, the memory of two young girls as they came into the observatory study one morning to inquire about "course 3 in astronomy." They seemed really interested in the subject and it puzzled me why they hesitated until one of them made bold to say, "We are the kind of girls that like to curl up on the sofa and read Astronomy with an Opera-Glass by Serviss." Then I understood. They feared that if they studied the stars according to the ways of science, they would lose them as friends. However, they made the venture and the loss feared turned out to be gain. So with the hope of aiding others, who may wish to add to the dream-pleasure of the stars a little real knowledge, these lessons are offered.

In this ill-favored time for education when it is the fashion for teachers to do everything and students merely to imbibe as babes do from a bottle, it is, I know, daring and hazardous to throw down a challenge for genuine work. These lessons are such a challenge. Let us begin with Greek. It is not so alien to our subject as might seem, for it has long been the practice of astronomers to designate the bright stars by the Greek letters, followed by the Greek or Latin genitive of the constellation name. Thus, the brightest star in Taurus is α Tauri. The method of referring to stars by their place in mythological figures, as that in the tip of the left horn of Taurus, is too cumbersome for the student.

After the Greek alphabet, or in connection with it, comes the study of almanacs, star-maps, and such parts of descriptive astronomy as are needed in making first observations. There are a number of satisfactory authorities, but for convenience and definiteness, references in these lessons are usually made to the following:

Dr. Jayne's or the Old Farmer's Almanac. The former is published in several editions, adapted to different sections of the country, and is given away at drug stores. The latter contains much more astronomical data, and though designed especially for New England and neighboring states, it is serviceable almost anywhere, and may be obtained from the Old Farmer's Almanac, Incorporated, Boston, Mass., price 15 cts.

Star maps by Young, called Young's Uranography, published by Ginn & Co., Boston, Mass., price about 35cts. In addition, those who work without a teacher will find it convenient to refer to the twelve maps in Proctor's Half Hours with the Stars, published by G. P. Putnam's Sons, New York, price $2.20, before the war.

Young's Elements of Astronomy, published by Ginn & Co., Boston, Mass., a book that is to be found in many schools and public libraries.

While auxiliaries, such as these, are important and require attention, they should never have first place. That belongs to the direct study of the heavenly bodies. We are to look up and learn by seeing and thinking.

For us, as for the first star-gazers, the sun is the dominating body of the heavens, and at the beginning, our problem like theirs is to find out about its apparent motions, both as referred to the horizon and to the stars. The general problem is threefold: to obtain a long and a short series of observations, to check and interpret them, and then use them as a key to the riddle of the seasons. Long before that goal is reached, we shall be hungry for books. It is surprising how interesting a text-book and globe become when they serve to verify and supplement one's own observing!

Let us take, then, as one of the observing topics in our first lesson, the location of the sun's path for a particular day. The simplest method is that of direct eye-estimates, and a fair idea of the path is gained by looking often at the sun, noting its position with regard to trees or buildings, and determining carefully two critical points, for example, southing and setting. How this can be done without special apparatus is shown by the following illustrations:

Wide View, Lawrence, Kan., Saturday, June 24, 1916.
Sun's zenith distance observed directly.

"About noon I stood close to a telephone pole near the house, and located the zenith by leaning the head back, as I faced south, and following the pole's line of direction up to the heavens. Then the arc of 90°, between this point and the horizon, was divided approximately, by eye, into thirds, that is into 30° spaces, and I estimated the sun to be 10° above the upper point of division, making its zenith distance 30° — 10°, i. e., 20°.

"When in like manner, I faced north, the sun seemed a little less than two thirds of 30° from the zenith, and after looking several times I called it 30° — 12°, or 18°. So the mean of the two estimates gives 19° as the sun's zenith distance on the date of observation. Though at the time thin clouds covered the sun, dark glasses were needed in looking at it directly for several moments."

Lone Elm Astronomical Station, Fall River, Wis., Monday, Jan. 7, 1918.
Estimated direction of Sun's setting point.

"A few minutes before sunset, I went to the big maple on the front lawn where there is a very good view of the southwestern horizon. Here I fixed the west point by the road which runs east and west, and as the sun disappeared, the point, marked on the outline in the notes, I estimated to be 30° south of the west point. The time by my Waltham watch, correct by telephoned time at four o'clock, was $4^h\ 35^m$." A. L. P.

The errors found by calculation are 3° for the first and 2° for the second observation, but they might be much larger and still the data be valuable for the ends in view. To cut off part of the sun's light at noon, which is desirable both for the sake of the eyes, and to insure accuracy, spectacles with tinted glasses that have been darkened by smoking are satisfactory. Those that are made really dark enough are difficult to obtain. Another suggestion should be added: guard against the tendency to estimate distances near the zenith too large.

Important as the sun is, rightly called the storehouse of energy for our system of worlds, nevertheless the lure of astronomy lies in the heavens at night. Few even of the most exacting scientists would be free from the thrall of their wonder and beauty. Meteors, comets, moon, planets, and stars call to us in the language of light, but the stars by reason of their numbers are imperious, and naturally we turn first to them when the evening study of the sky begins.

Let us assume that this time comes in the winter months and that the constellation, Orion, is known, then the preliminary preparation, to be made in the daytime, consists mainly in learning to use Map II of Young's Uranography. That its double page is crowded with numbers, lines, letters, and symbols of unknown meaning need not cause perplexity. All will receive attention in due time, but for the present, turn to a few simple points. Looking at the upper, left-hand corner, see what symbols are given to the brightest stars, those that are of zero or first magnitude. Find where Orion is, note its prominent configuration is a fairly regular quadrilateral, with a slanting row of stars near the middle. Pick out the stars named by the first eight letters of the Greek alphabet, fixing in mind the position of four or five. Thus, beginning with the brightest and passing upward, the three corners of the figure are given by $\beta$, $\gamma$, $\alpha$ and the outer ones in the row of three are $\delta$, $\zeta$.

When the map picture of Orion is thoroughly familiar, try to plan alignments from its stars to those in neighboring constellations so as to identify the latter at night. Take, for example, Taurus which may be called the constellation of the two V's, the small, bright one, known as the Hyades, and a larger one formed by $\alpha$, $\beta$, $\zeta$. The last is reached by extending the star-line $\beta$ $\gamma$ Orionis its own length upward; $\beta$ is at the upper end of the line through this $\zeta$ and $\alpha$ Orionis, prolonged about half its length; and the very bright star on the Pleiades side of $\gamma$ Orionis —$\zeta$ Tauri, which makes with them an equilateral triangle, is of course $\alpha$ Tauri. From these stars, others desired are readily identified, and, the Pleiades, the cluster which gives distinction to the whole constellation, is known by almost every one.

Steps like these should be conned over and over with several constellations, till one can see the groups with eyes shut, make estimates, and follow out the star-lines. And yet, though star-maps are studied never so faithfully in the daytime, it must be acknowledged that, when night comes and actual observing begins, they appear to many students a vain device, but slightly connected with celestial objects. Then, if ever, a teacher right at hand is appreciated, but perhaps it is better to depend upon patient, persistent effort on one's own part. While, later, little thought need be given to the horizon, at the beginning, especially if one works alone, it is well to hold the map so that a well-known, conspicuous constellation corresponds with the same group in the sky, both as regards altitude and points of compass. It should not,

then, be difficult to find the stars already learned on the map and to identify others by the general methods of alignment planned beforehand, though exact agreement between lines and angles on a flat surface and on the concave dome of heaven is not to be expected.

After several constellations have been identified with certainty, it is desirable to enter in the notes brief accounts of them, somewhat like the following:

Manitowoc, Wis., Saturday, Sept. 22, (?), 1917.

The Constellation, Pegasus.

"The four principal stars of Pegasus form a huge box or square in the sky, though indeed the brightest one of them really belong to Andromeda. Near $\alpha$ and $\beta$ Pegasi are rather conspicuous triangles of stars. The constellation is one that is readily found and is helpful in identifying Pisces, Andromeda, and Delphinus." W.

As just intimated, taking notes is a part of taking observations. The note-book used should not be too large, seven by eight inches is a convenient size, and the paper should be unglazed and unruled, for the writing is to be done mostly with pencil and sketches are often required. Unfortunately, making a written record is irksome to certain students. I have had them say to me, "I should enjoy the observing, were it not for making notes." It would be almost as reasonable to say, "I should enjoy my meals, were it not for eating the food." Since it is quite possible to vitiate the pains-taking work of a whole evening by careless, defective notes, even beginners should record scrupulously according to the following astronomical rules:

1. Begin the record for each evening on a separate page.
2. At the head of every page, name the place of observing, day of week, day of month, and the year.
3. Write out notes in detail so that others following them could take the same observations in the same way.
4. Keep all records of actual observations in pencil, making in ink any corrections necessary. This is the fundamental record which no copy can supersede.
5. In general, do not reject an observation once taken. The fact that it is discordant when compared with others of the same series is never a reason for rejection.

With regard to the observations themselves, what is perhaps the most important precept may be stated thus: Independence is the cornerstone of good observing. In so far as any observation is biased by what others see and do, in so far it is worthless.

Bringing together and arranging the various topics suggested, we have the following as the formal statement for

LESSON 1.

1. Memorize the names and learn how to make the symbols of the first eight letters of the Greek alphabet. Young's Uranography.

2. Designate the star $\alpha$, according as it is in Canis Major, Orion, Taurus, Gemini, or Auriga. Young's Elements, Art. 422, Appendix, Table IV.

3. From Dr. Jane's or the Old Farmer's Almanac, find how the bright planets are distributed as "morning and evening stars" in 1920.

4. Define celestial sphere, zenith, nadir, visible horizon, sensible horizon, vertical circles, prime vertical, celestial meridian, altitude, and zenith distance. Young's Elements, Arts. 7, 14, 15, 16, 17, 19.

5. Study Map II of Young's Uranography, especially the constellations named in topic 2. With one of the five that is known, practice making alignments that will help in identifying others in the heavens.

6. In the evening when the sky is clear, find Orion noting just what stars are named $\alpha$, $\beta$, $\gamma$, $\delta$, $\epsilon$, $\zeta$.

7. Identify four constellations not already known, and give in the notes the principal alignments used in locating one of them.

8. Write out a short account of two of these, including only the few simple points that are noted directly. Afterward, not before, read the descriptions given of them by Young or some other author.

9. As early as practicable in the new year, 1920, determine the sun's altitude at noon, following the general method already illustrated.

10. On the same date, or on one very near, locate in a similar manner the setting point of the sun.

May the writer add that should the number not be too large, of which there is little danger (or hope!), it will, if desired, be a pleasure to have some correspondence with any who may study these lessons themselves or use them in teaching others. Copies of observations, properly recorded, will be welcomed, and those that are satisfactory mentioned in following lessons.

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## A CRITICISM OF PICKERING'S SUGGESTED EXPLANATION OF THE PHENOMENA PRESENTED BY A NOVA.

By A. C. GIFFORD.

In Popular Astronomy, November 1918, Professor W. H. Pickering gives a suggested explanation of the phenomena presented by a Nova. He attributes the outburst to a collision of a planetoid with a star. This is a great advance on other recent theories in that it recognizes the collision of dense bodies as the source of the sudden liberation of energy, but on examination it fails to explain the characteristic peculiarities of a typical New Star.

Before advancing his own theory Pickering glances at three or four

others. With regard to the theory that the appearance is due to the collision of two stars, he raises two objections:

First: That Novæ are too frequent.

Second: That a Nova cools too quickly.

These objections are of very different weight. If we take into account the dark stars that are now believed to exist, and the special crowding in certain parts of our stellar system the former vanishes.

The rapid fading away of the intense radiance is, however, the crucial fact which a theory must either explain or become itself definitely untenable.

When the partial character of a stellar impact and the consequent formation of a Third Body, explosively hot and gravitationally weak and therefore thermodynamically unstable, are fully recognized, when, further, selective molecular escape is taken into account, the grazing collision of two suns explains not only the sudden rise in brilliance, the astonishing transformation of energy, the otherwise inexplicably quick decline, but in addition the characteristic changes in the spectrum, the occurrence of planetary nebulæ, variable stars, double stars and visual and spectroscopic binary systems. This theory was published by Professor A. W. Bickerton in the Transactions of the New Zealand Institute in 1878, 1879 and 1880. Subsequent discoveries have tended to confirm it.

Now the crucial tests, the quick decline and the changes in the spectrum which confirm the partial impact theory, are found to be fatal to that of Pickering.

A consideration of the effects of such a collision as he imagines shows them to be far less intense but more lasting. His objection to the theory of colliding suns rests on the assumption that the impacts are direct. He states that if two stars come into direct collision they require centuries instead of weeks to cool. Surely this should read "millions of centuries instead of weeks".

Direct collisions are, however, so extremely rare in comparison to grazing ones that it is unnecessary to consider them in this connection further than to remark that whilst such encounters must certainly produce New Stars, they will never give rise to anything like a typical Nova, one of the most striking peculiarities of which is its evanescent character. There is no record of a New Star caused by direct collision having ever been observed.

A near approach of two stars also fails to give rise to the phenomena of a typical Nova. Pickering's contention, that no tidal effect could increase the radiance of a star 100,000 times, carries conviction with it.

He also disposes quite satisfactorily of the star-meteor shower suggestion by showing that the energy liberated in such a case is infinitesimal compared with that indicated by observations of New Stars.

The popular theory that a Nova is due to the collision of a star with

a nebula is completely discredited by Pickering without his ever mentioning the strongest argument against it. He shows that if this theory is to account for the observed outbursts we must accept a series of absurdities. We should have to suppose that all the nebulæ struck by stars are either very small, or if large then thin flat sheets; that in every case the nebulæ are receding from us and the stars approaching us almost directly; that the stars always pierce the nebulous sheets at right angles to the directions of their greatest extent; and to cap this delightful series of improbabilities, that in every case the maximum effects are all over before the collision which causes them has ever begun! Surely this is enough to dispose of the star-nebula suggestion! But it is strange that such a theory could ever have been entertained, since it cannot face even the preliminary test.

Every New Star gives evidences of a colossal transformation of molar into molecular energy. If the theory cannot account for this it fails utterly and immediately and further refutations are a slaying of the slain. The impact of a star with a nebula is not catastrophic or spectacular. Such impacts are happening always and continually.

If the nebula is of the tenuity ascribed to the Great Nebula in Orion it will require 114,000,000 years to liberate the energy transformed in one hour by the collision of suns.

The observed phenomena associated with temporary stars suggest that the bodies concerned are of stellar rather than nebular density. Pickering's hypothesis is good in that it recognizes this fact, but there are several serious objections to it. The type of collision that he imagines, that of a planetoid plunging with a velocity of about 400 miles a second into the photosphere of a star, must result in the complete coalescence of the two bodies. This is incompatible with the transient character of a Nova. Great as the explosion must undoubtedly be when the planetoid has penetrated the star's photosphere, it is quite unable to produce the effects demanded of it. There is not sufficient available energy to enable the products of the explosion to escape from the system. The planetoid has to share its thermal energy with the star it strikes and also to hurl upwards a mass much greater than itself. The velocity of the ejected material is therefore far less than that with which the bodies approach one another.

Even if the mass projected were but twice that of the planetoid it would rise only to a height equal to the radius of the star. Some portions, of course, might be thrown higher but then others would not rise so high. We may take it for granted then that in a collision of the type Pickering suggests, the materials ejected by the explosion would, after rising a certain height, fall back again on to the star. It is sometimes assumed that when two stars meet they will be changed into an infinitely extended nebula. This is not correct, for if the stars approach with parabolic velocity the energy will be just half that required to dissipate the mass. It will therefore be sufficient only if the

suns are equal and both entirely gaseous, to form a gaseous sun with twice the diameter of either. This makes the surface eight times that of one star.

Pickering imagines a planetoid, of the size of our moon, scattering the photosphere of the star till its surface is increased 6,000 times, and therefore its radius multiplied by 77.5. Thus a far greater effect is assumed to be produced by this small mass than is possible in a complete collision of two suns in which the liberated energy is 27,000,000 times as great.

The impact of such a wandering planetoid on a star though unable to produce a typical New Star must give rise to some most interesting phenomena. It will undoubtedly cause a sudden but not transient increase in brightness. The impact, being naturally oblique, will add a new rotation to any previously existing. The explosion, not having sufficient energy to enable the products to escape, will result in one portion of the star being heated to a much higher temperature than the rest of it. There being no thermodynamic instability, as there is in the case of a graze, the cooling will be slow and for ages the rotating star will throw its revolving searchlight through space. Pickering asumes that the loss of energy takes place by radiation. This, however, except at exceedingly high temperatures is a comparatively slow process and we must remember that the temperature produced by the penetration of a planetoid into a star will be low compared with that of the Third Body in a grazing encounter between two suns, for in the former case the planetoid shares its heat energy with a portion of the star. In the case of the unstable Third Body we do not have to appeal to radiation to carry away suddenly the vast stores of energy. It is taken into distant space by the departing molecules of gas.

The phenomena observed in Nova Aquilæ 3 afford a perfect touchstone for determining the relative merits of rival theories. The outward rush of metallic elements with stupendous velocity which instead of suffering retardation was accelerated continuously for many days, the shells of gas flying outwards in all directions with a speed far greater than 1000 miles a second, which speed after rising to a maximum remains undiminished until the light fades away, the characteristic light curve, the sequence of spectral changes predicted long ago, all agree perfectly with the theory that the outburst is due to a grazing collision between two stars, but cannot be explained at all by the impact of a planetoid with a star.

Pickering's theory fails because the sequence of events following the collision he imagines, is entirely different from those which have been observed again and again in every typical Nova.

Wellington, N. Z., Sept. 4, 1919.

A Reply to Mr. Gifford's Criticism.

A paper has recently been submitted to me at the request of Mr. A. C. Gifford comparing the Planetoidal Theory of the genesis of a nova with that proposed by Professor Bickerton. To this paper Mr. Gifford courteously suggests that I should reply. I am at a slight disadvantage in the matter, since I have no means of referring to Professor Bickerton's papers on the subject, although I read them very many years ago.

To deal first with Mr.Gifford's main objection to the planetoidal theory, that the collision would not furnish sufficient energy to enable the products of the explosion to escape from the system, I would refer him to my second paper, published last May, entitled "The Mass of a Planetoid capable of producing a Nova," where the whole question is dealt with quantitatively, and not simply by assertion (Popular Astronomy, 1919 **27**, 275). Mr. Gifford has moreover apparently failed to notice the statement contained in my first paper that the enormous light given out by the nova "was due not to the collision itself, but rather to the explosion caused by the collision," in other words, "to the stored energy of the star." The energy released is not that employed in pulling a trigger, but rather that in the resulting explosion of the gun. The tremendous energy of a solar eruptive prominence is well known. Some of these objects rise with a velocity of 400 km. per second, and attain an altitude of 600,000 km. (400,000 miles) above the chromosphere. If the surface of a star could be so shattered by a collision as to release at once all the pent up energy of its interior, instead of letting it gradually trickle out in a series of prominences, we can well imagine that the result would be marked,—and sufficient. The cooling of the released masses of gas, as in the case of a prominence, would obviously be rapid.

Dealing now with Professor Bickerton's hypothesis itself, there are to my mind three objections to it. (*a*) As I recall it, he stated that two stars were supposed to graze past one another, each shaving off a portion of the atmosphere of the other. These two atmospheres were supposed to unite to form a third and separate body, which gave out the broad bright bands of the spectrum of the nova. The dark narrow absorption lines were due presumably to the two stars. Some of these dark lines are occasionally double, which fits in well with the hypothesis of there being two massive colliding bodies. Unfortunately, however, the lines always indicate an approach to the Sun, which seems unlikely in so many cases, and moreover this approach is at velocities unheard of among the stars, in the case of Nova Aquilæ attaining speeds of 1,500 and 2,200 km. per second. In the meantime the shaved off atmosphere is practically stationary, but expanding with a similar velocity. If my recollection of Professor Bickerton's hypothesis is incorrect, I trust Mr. Gifford will correct me. The second and third of my objections to it may be mathematically expressed.

(*b*) Let us consider now the projection of a star on a plane to be of unit area. If another star of equal size collides with it, the projected area of possible collision will be nine times as great. If the colliding stars meet exactly, or if their point of first contact lies within 30° of their lines of relative motion, we may call it a direct hit, otherwise we will call it a graze. The area in which a direct hit will occur, will be four-fifths as large as that in which we may have a graze. Consequently out of every nine novas, four will be the result of direct hits, and the duration of the resulting luminous phenomena would be measured in centuries instead of in days. If we define a graze still more rigidly, as perhaps Professor Bickerton's theory would demand, then there would be a still larger proportion of direct hits.

(*c*) The probability of a close approach of any sort occurring between two stars has been already discussed in POPULAR ASTRONOMY, 1919 **27**, 501. There are 13 known stars, three of them double, lying within a distance from us of 5 parsecs, whose luminosity is as great as 0.01 that of our Sun. There may be as many as 20 in all, but it is not likely that there are any more. In a sphere whose radius is one dekaparsec there should be 160. Within 100 dekaparsecs of the Sun there should be 160 million. Assume that there are 100 dark suns to one so bright that its luminosity is 0.01, then this would give us 16,000 million stars, $16 \times 10^9$, in this volume of space. The frequency with which other stars are likely to pass within 93,000,000 miles of our Sun is found to be once in every fifty millions of millions of years, that is once in $5 \times 10^{13}$ years. Allowing for the assumed hundredfold number of dark suns, this becomes $5 \times 10^{11}$. Within the volume mentioned this event will occur $16 \times 10^9$ times as frequently, or once in 30 years. That is to say, we find that once in 30 years independent stars located at a distance of not more than 100 dekaparsecs from us, or 3260 light years, will pass one another within 93,000,000 miles. They would come within grazing distance once in 250,000 years. If novas were produced by the method advocated by Mr. Gifford they would seem to be of rather infrequent occurrence. In point of fact, at least three novas have occurred within the specified distance from our Sun within the last thirty years. It would appear therefore that there must be some other explanation of the event than the grazing collision of two stars.

WILLIAM H. PICKERING.

Mandeville, Jamaica, B. W. I., October 30, 1919.

# THE ANNULAR SOLAR ECLIPSE OF NOVEMBER 22, 1919. THE LUNAR ATMOSPHERE.

By W. H. PICKERING.

Partial eclipses are usually considered of but little value by astronomers, but it was determined to try and secure something more interesting than the times of contact at this one. The southern limit of the annular phase passed about 35 miles to the north of the Harvard Station, and crossed only the north-eastern portion of the Island of Jamacia. The eclipse was most nearly central with us at $20^h\ 42^m$ E.S.T. At this hour we expected an unclouded sky, but the weather was unusually unfavourable, and we observed only between passing clouds. The instrument employed was the 11-inch refractor stopped down to 3 inches, with a magnification of 330, or 110 diameters to the inch. The object of using so high a power was in part to reduce the light, but mainly because we wished to insert a screen in the eye-piece cutting off half the field of view, and for that purpose this particular eye-piece was the most convenient one to employ. A narrow wedge-shaped piece of paper attached to the screen, and which was afterwards measured, enabled us to estimate distances. A piece of red glass was substituted for the reflecting prism in the telescope, thus materially reducing the illumination. In consequence it was possible to use a comparatively light shade glass, giving an orange colored image.

As the Moon advanced slowly across the Sun's disk, the darkening landscape and gray sky reminded us of the spectacular eeffcts visible at a total eclipse. As the crescent narrowed, particular attention was paid to the cusps, and shortly before they were at their narrowest, and until $13^m$ afterwards, faint brushes of light were seen prolonging them. The cusps were nearly concealed behind the screen, which was placed alternately at right angles to them, so that merely their tips showed. With the high power employed only one cusp was in the field at a time. The shade glass was twisted around and shifted into different positions to make sure that the brushes were not due to defects or irregularities in its interior. They measured 40″ in length, and were seen without difficulty. At $21^h\ 05^m$, or $23^m$ after the narrowest phase had passed, they were no longer visible. Much more satisfactory re-

sults would have been secured but for the constantly passing clouds. Venus was conspicuous to the naked eye in the zenith, and it had been planned to look for Jupiter, which would probably have been seen, and for Arcturus which perhaps might have been seen, if its location were first determined by a telescope. Owing to the clouds our attention was confined to the cusps.

Since the brightness of the brightest portion of the corona is but one-fiftieth that of the full moon, it is clear that the brushes observed were not due to the corona. They were probably due chiefly to the chromosphere, and perhaps in part to the refracted light of the Sun's limb by the lunar atmosphere. They exhibited no knots or irregularities such as might be due to prominences. Where farthest from the cusps their altitude above the solar limb was 3″.

Althongh the lunar atmosphere is very rare, yet on account of the small force of gravity, it rises to a considerable altitude above the surface of the Moon. It halves its density every 21 miles, instead of every 3.5 as with us. Therefore at 20″ from the Moon's limb it is half as dense as it is at its surface. The nature of the solar corona as is well known is two-fold, it is partly of radial, and partly of uniform structure. The uniform portion gives the green line in the spectrum, and is therefore partially solar. If wholly solar, since the light would be reflected mainly at right angles, it should be strongly polarized. Such however is not the case; the polarization is comparatively weak. This might be explained if the light were due to reflection from solid meteoric bodies or dust near the Sun. This cannot be, however, since they would be vaporized in its vicinity. This therefore implies that a considerable portion of the light is reflected to us at a very obtuse angle, as would be the case if it came from the atmosphere of the Moon. If much of the light came to us from this source it might be shown by a comparison of measures of the brightness of the corona at both limbs made towards the beginning and the end of totality. We could thus see if the approach of the Moon to a given area of the corona caused it to brighten. The outer corona, on the other hand, must be mainly or wholly a solar appendage.

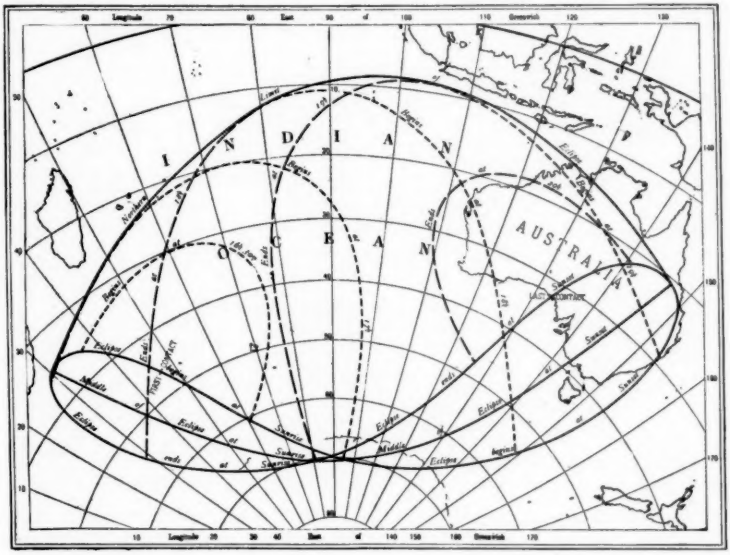
If a considerable portion of the light of the inner corona is due to the Moon, this would render appreciably more remote our chance of photographing the true corona without an eclipse.

Mandeville, Jamaica, B. W. I., November 25, 1919.

# ASTRONOMICAL PHENOMENA IN 1920.

## Eclipses.

In 1918, and also in 1919, there was a total eclipse of the sun. In 1920 there will not be a total eclipse of the sun, but there will be two partial eclipses. There will also be two total eclipses of the moon during the year. None of these eclipses will have as great an interest for the professional astronomer as a total eclipse of the sun has. This is because a total eclipse of the sun affords an opportunity for investigating certain important problems which cannot be attempted at any other time. However, the phenomenon of an eclipse, either of




Partial Eclipse of May 17, 1920.

*Note*:—The hours of beginning are expressed in Greenwich Mean Time.

the sun or of the moon, is sufficiently rare to make any eclipse at least an event somewhat out of the ordinary for the average person. Everyone is impressed with the fact that the laws of motion of the celestial bodies are so accurately known as to make it possible to predict, even to the fractional part of a second, the time and circumstances of an eclipse years before it is to occur.

The first eclipse of the year will be a total eclipse of the moon on May 2. This eclipse will be visible from beginning to end in the eastern part of the

United States. At points in the middle and western parts of the United States the moon will rise eclipsed. The circumstances of the eclipse are as follows:

| | d | h | m | |
|---|---|---|---|---|
| Moon enters penumbra | May 2 | 10 | 49.3 | G.M.T. |
| Moon enters umbra | 2 | 12 | 00.8 | " |
| Total eclipse begins | 2 | 13 | 14.7 | " |
| Middle of the eclipse | 2 | 13 | 50.9 | " |
| Total eclipse ends | 2 | 14 | 27.1 | " |
| Moon leaves umbra | 2 | 15 | 41.3 | " |
| Moon leaves penumbra | 2 | 16 | 53.2 | " |

The magnitude of the eclipse, i. e., the depth which the moon is within the earth's shadow at maximum, will be 1.224 times the moon's diameter.

The second eclipse of the year will be a partial eclipse of the sun on May 17. It will occur chiefly in the south Indian Ocean. The only land, except the smaller islands, from which it will be visible is the western half of Australia. This eclipse will be very nearly total. At the time of greatest eclipse 97.3 percent of the sun's surface will be obscured. The circumstances of this eclipse are as follows:

| | d | h | m | | Long. ° | ′ | Lat. ° | ′ |
|---|---|---|---|---|---|---|---|---|
| Eclipse begins | May 17 | 16 | 16.9 | G.M.T. | —46 | 28 | —46 | 11 |
| Greatest eclipse | | 18 | 14.7 | " | —107 | 32 | —69 | 05 |
| Eclipse ends | | 20 | 12.6 | " | —133 | 03 | —32 | 07 |

The third eclipse will be another total eclipse of the moon on October 26-27. This will be visible in the part of the earth in which the eclipse of May 2 was invisible. The beginning of the eclipse will be visible in the western part of North America on the morning of October 27. In this region the moon will set eclipsed. The circumstances of the eclipse are as follows:

| | d | h | m | |
|---|---|---|---|---|
| Moon enters penumbra | Oct. 26 | 23 | 24.5 | G.M.T. |
| Moon enters umbra | 27 | 0 | 25.6 | " |
| Total eclipse begins | 27 | 1 | 28.6 | " |
| Middle of the eclipse | 27 | 2 | 11.4 | " |
| Total eclipse ends | 27 | 2 | 54.3 | " |
| Moon leaves umbra | 27 | 3 | 57.5 | " |
| Moon leaves penumbra | 27 | 4 | 58.7 | " |

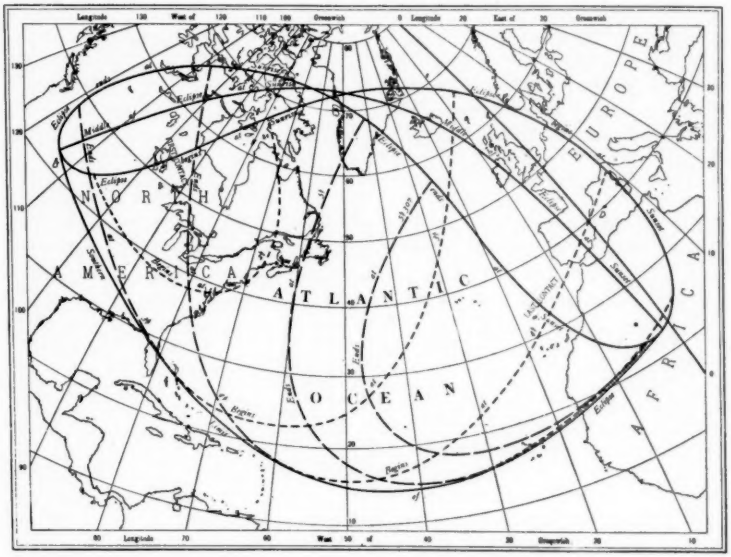
The magnitude of the eclipse, i. e., the depth which the moon is within the earth's shadow at maximum, will be 1.404 times the moon's diameter.

The fourth eclipse of the year will be a partial eclipse of the sun on November 10. As the eclipse of May 17 is limited to the southern hemisphere, this one is limited to the northern hemisphere. It will be visible throughout its duration generally in the North Atlantic. Only the beginning of the eclipse will be visible in Western Europe and Northern Africa. Only the end will be visible in the northwestern part of North America. The entire eclipse will be visible in the United States east of a line from Florida to Puget Sound. The circumstances of the eclipse are as follows:

| | d | h | m | | Long. ° | ′ | Lat. ° | ′ |
|---|---|---|---|---|---|---|---|---|
| Eclipse begins | Nov. 10 | 1 | 47.3 | G.M.T. | +96 | 25 | +53 | 12 |
| Greatest eclipse | 10 | 3 | 52.0 | " | +30 | 00 | +69 | 57 |
| Eclipse ends | 10 | 5 | 57.1 | " | +15 | 20 | +34 | 00 |

At the time of greatest eclipse about three-fourths of the sun's surface will be obscured.

The diagrams, as well as the data, of the eclipses are taken from the *American Ephemeris* for 1920.




PARTIAL ECLIPSE OF NOVEMBER 10, 1920.

*Note*:—The hours of beginning are expressed in Greenwich Mean Time.

## THE PLANETS.

The accompanying diagrams (Figures 1 and 2) are designed to make it easy to determine the positions of the different planets in the sky throughout the year. A brief inspection of these charts will enable one to determine which of the planets are visible at any particular date.

As is well known the earth makes a complete circuit about the sun in a year. However, from the earth the sun appears to revolve through a complete circuit of the sky in a year. This apparent motion, therefore, causes the sun to advance approximately two hours eastward each month. The charts show a belt of the sky extending 30 degrees on each side of the equator. As the path of the sun intersects the equator at the date of the vernal equinox and again at the date of the autumnal equinox, its path is indicated by the curve which intersects the equator at zero hours and at twelve hours, lying in the northern hemisphere between zero hours and twelve hours, and in the southern hemisphere between twelve hours and zero hours again. To locate the sun in the sky, therefore, it is only necessary to determine the number of months after March 22, the date of the vernal equinox, and to multiply this number by 2, the product representing approximately the right ascension of the sun for that date.

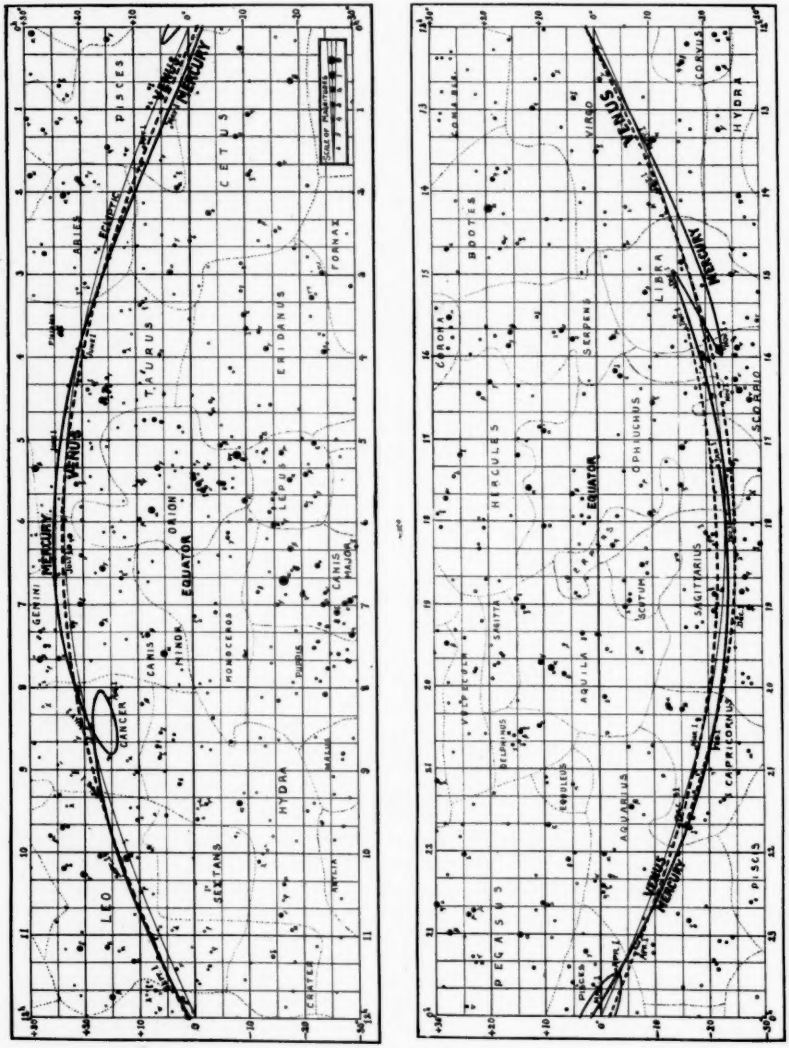



FIG. 1. Apparent paths of the planets Mercury and Venus among the stars during the year 1920.

Any planet which happens to be within an hour of the sun will be invisible, while any planet which is between one and two hours from the sun will be visible with difficulty. Any planet two hours or more distant from the sun will be easily visible.

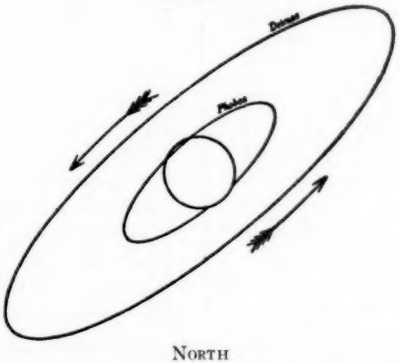
An inspection of the Figures shows the following facts concerning the different planets:

*Mercury* begins its course on January 1 in the constellation Ophiuchus and moves eastward until about the middle of March. It then describes a loop in the constellation Pisces, after which it proceeds eastward again until it reaches the constellation Cancer in July. Here it describes a smaller loop and then moves eastward until the first of November when it takes up a zigzag course across the ecliptic, moving westward during the month of November. In December it moves eastward again, crossing the ecliptic and ends the year less than one hour east of its starting point.

Mercury will be in conjunction with the sun on the following dates: February 5, March 19, May 25, July 26, September 8, November 15. It will therefore be invisible for a week or more before and after each of these dates. It will be at a point of greatest elongation west on April 16, August 14, and December 3. Mercury will be visible in the east just before sunrise near these dates. It will be at a point of greatest elongation east on March 3, June 29, and October 24, and will consequently be visible in the west just after sunset near these dates.

*Venus* at the beginning of the year will be in the constellation Libra, less than two hours west of Mercury. Its course is uninterruptedly eastward throughout the year. Because of this it will move completely around the sky and will complete one-fourth of a new circuit. It will end the year in the constellation Capricornus.

This planet will be plainly visible as a morning star until May 1. During May, June, July, and August it will be moving eastward with the sun and will be invisible for this period. It will be in conjunction with the sun on July 3. After September 1 it will become an evening star and will remain visible for the remainder of the year. In December it will be very brilliant.




Apparent orbits of the Satellites of Mars, at date of opposition, April 20, 1920, as seen in an inverting telescope.

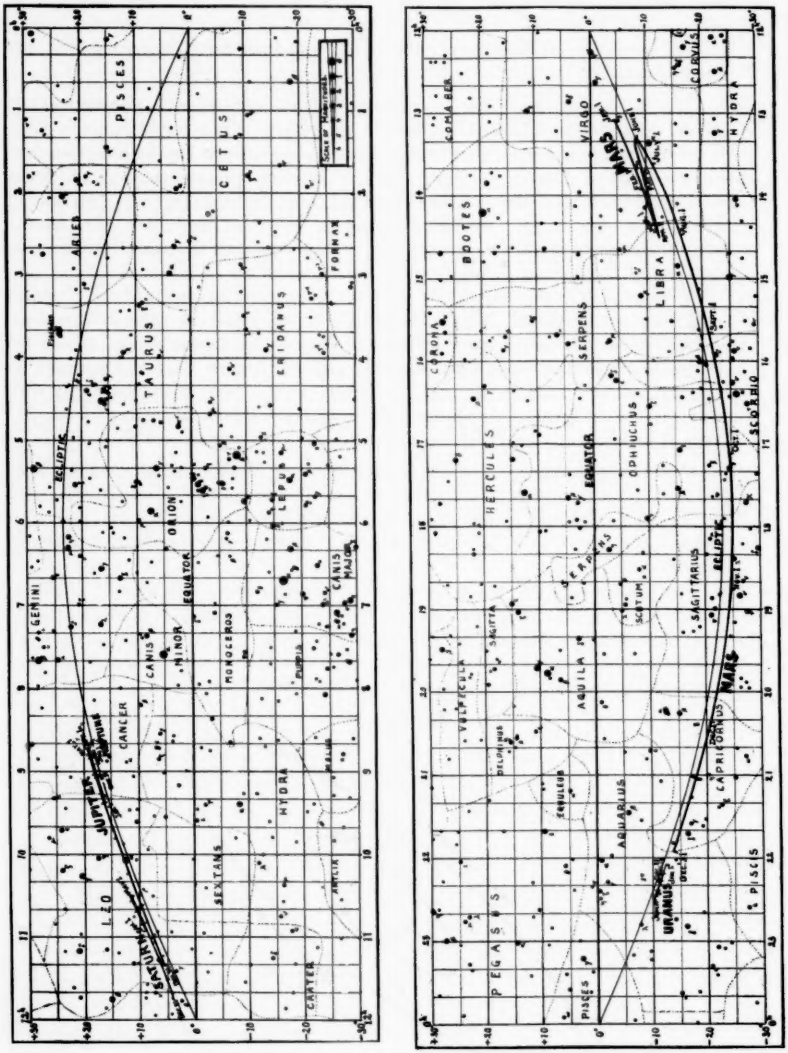



FIG. 2. Apparent orbits of the planets Mars, Jupiter, Saturn, Uranus and Neptune among the stars during the year 1920.

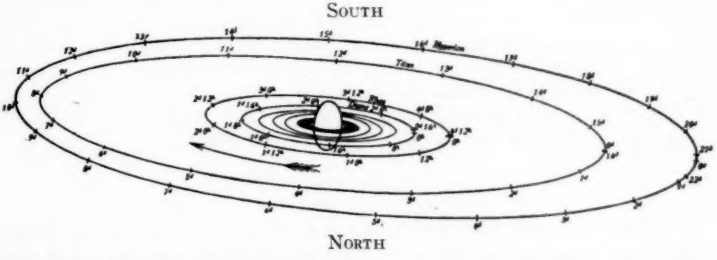
*Mars* will be moving eastward slowly in the constellation Virgo at the beginning of the year. It will move westward in the same constellation during April and May. About June 1 it will change its direction of motion again and move eastward almost exactly parallel to the ecliptic for the rest of the year. It will end the year on the boundary between Capricornus and Aquarius.

Mars will be in quadrature, 90° west of the sun, on January 13; in opposition to the sun on April 20; in quadrature, 90° east of the sun, on August 3. It may therefore be observed in the morning sky during the first few months of the year and in the evening for the remainder of the year. Mars does not come into conjunction this year.

*Jupiter* will be moving westward in the constellation Cancer during the first three months of the year. It will then move eastward into Leo and end the year in the eastern boundary of this constellation. In August it will be near the bright star Regulus. The sun, however, will also be in that part of the sky in August so that Jupiter will not be visible during this month.

Jupiter will rise shortly after sunset at the beginning of the year. It will be in opposition to the sun and consequently will rise at sunset early in February. It will be on the meridian at sunset in the latter part of April. During August and a part of September Jupiter will be lost in the rays of the sun. It will, however, become brilliant as a morning star again before the end of the year.

An interesting circumstance at the time of the opposition of Jupiter on February 2 is that the earth will then be very nearly in the plane of the orbits of the satellites. The motion of the satellites therefore as seen from the earth will appear to be back and forth along straight lines. During March an unusually large number of eclipses of the satellites occurs. A list of these eclipses will be published in the February number.




Apparent orbits of the seven inner Satellites of Saturn, at date of opposition, February 27, 1920, as seen in an inverting telescope, and elongated in the ratio of two to one in the direction of their minor axes.

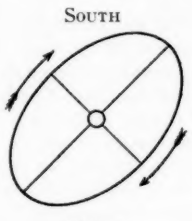
*Saturn* will move westward in Leo during the first four months of the year. It will then move eastward and cross into the constellation Virgo at the end of the year. Saturn and Jupiter will be rather close together in the sky at the end of the year.

Saturn, the planet which has more interest because of its peculiar formation than any other planet, will be visible throughout the year except during August and September. It will be most favorably situated for evening observation during the first half of the year.

*Uranus* will move eastward in Aquarius until June, and then westward along nearly the same course until the month of November when it again turns and follows nearly the same path eastward until the end of the year.

Uranus will hardly be visible before the first of April. It will then be in the southeastern sky just before sunrise. After August 1 it will be visible in the evening. This planet cannot be seen with the naked eye, although a small telescope or even opera glasses will enable one to see it.

Apparent orbits of the Satellites of Uranus at date of opposition, August 26, 1920, as seen in an inverting telescope.




Apparent orbit of the Satellite of Neptune at date of opposition, January 30, 1920, as seen in an inverting telescope.

*Neptune* will move back and forth in the constellation Cancer. On December 31 it will be about 2 degrees east of its starting point. It will be visible in the evening from the beginning of the year until early in July. It will then be invisible until about September 1, when it will again be visible in the morning. This planet like Uranus requires a telescope to make it visible.

The Figures here given showing the orbits of the satellites of the several planets are copied from the *American Ephemeris* for 1920.

## The Comets.

The five comets of 1919, Kopff's, Brorsen-Metcalf, Metcalf-Borrelly, Finlay-Sasaki, and Schaumasse (1911 VII) may all be followed with the aid of large telescopes during part of this year.

The following periodic comets are due to return to perihelion during 1920. Only one of them, $Tempel_2$, is in very favorable position to be found.

1. Holmes' comet of 1892 was due at its fourth return in December 1919 but has not yet been picked up. At its return in 1899 and in 1906 it was very faint and in 1913 the conditions were so unfavorable that it was not seen. It is doubtful whether this comet will be found again.

2. Brooks' 1886 IV is due at perihelion about January 2 if its elements have not been changed since 1886. The conditions are quite unfavorable for its observation this year.

3. The comet Temple-Swift, which has been observed at several returns, should reach perihelion about February 1. It was faint in 1908, and in 1914 was

not favorably situated for observation and so was not found. This year its position is again unfavorable so that the comet may not be found.

4. The comet E. Swift (De Vico?) has not been seen since 1894 and is probably lost. If its elements have not changed it should be near perihelion about March 6 and on the opposite side of the sun, where it could not be seen.

5. Giacobini's comet 1900 III was observed again in November 1913. It is due at perihelion this year about May 7, but will then be almost behind the sun. It may possibly be found in February, with the aid of the ephemeris by Mr. Seagrave, published in the November 1919 number of POPULAR ASTRONOMY.

6. The comet $Tempel_2$ should be found early in the summer if a good ephemeris is published. It is due at perihelion about September 12 and in rather favorable position.

## METEORS.

Many of our readers doubtless noticed the report in the papers a few weeks ago of the unusually large meteor which fell into Lake Michigan. Although such a conspicuous phenomenon is rather rare, the bombardment of the earth, or at least the earth's atmosphere, by meteors is constantly going on. Many small meteors strike the atmosphere and are dissipated without becoming visible, but on any clear night the appearance of a "falling star" may be noted. On certain dates they are more frequent than on others, and at these times there are points in the sky from which they appear to come. These points are called radiant points. The American Meteor Society has done much to systematize the observing of meteors. Any one wishing to take part in the work of this society may receive suggestions and instructions by addressing Mr. Charles P. Oliver, President, Leander McCormick Observatory, University of Virginia.

The radiant points for certain dates and the average number for each night as predicted by Mr. W. F. Denning are given below. These are taken from the *Companion to the Observatory* for 1919:

| Date | Radiant $\alpha$ ° | Radiant $\delta$ ° | Average Number |
|---|---|---|---|
| Jan. 2 | 230 | + 52 | 18 |
| Jan. 3 | 230 | + 52 | 28 |
| Apr. 19 | 270 | + 33 | 8 |
| Apr. 20 | 271 | + 33 | 9 |
| May 3 | 334 | — 2 | 6 |
| Aug. 9 | 44 | + 57 | 48 |
| Aug. 10 | 45 | + 57 | 69 |
| Oct. 18 | 92 | + 15 | 21 |
| Oct. 19 | 98 | + 14 | 20 |
| Nov. 13 | 150 | + 22 | 20 |
| Nov. 14 | 150 | + 22 | 21 |
| Nov. 18 | 25 | + 43 | 15 |
| Dec. 10 | 111 | + 33 | 22 |
| Dec. 11 | 112 | + 33 | 23 |

## VARIABLE STARS.

For the use of those who possess small telescopes, the predicted times of maxima for a number of variable stars and the predicted times of minima for others will be published throughout the year a month in advance. These have been computed from the latest elements available for these stars. The magni-

tudes at maximum and minimum are given for these stars, and certain of them are visible, at maximum, to the naked eye. Hence even those who do not have telescopes may observe a few of these stars and note the change in brightness. It is a phenomenon which is certain to be of interest when first observed, as the inexperienced person usually thinks that the face of the sky is unchangeable, and is somewhat astonished at a change which takes place so conspicuously. The most prominent case of variation is doubtless the star Algol in the constellation Perseus.

OCCULTATIONS.

Instead of the usual list of occultations visible at Washington which we have copied from the *American Ephemeris* and published from month to month in former years, we shall print this year a list of occultations furnished by Mr. Arthur Snow, assistant in the Nautical Almanac Office, U. S. Naval Observatory. This list will be longer than that heretofore given and will give the approximate time and the section of the United States in which the occultation is visible. This phenomenon is also sure to elicit interest and may be observed with the aid of opera glasses or a small telescope.

SATELLITES.

Whenever Jupiter or Saturn or both are in favorable position for observation the lists of the phenomena of their satellites as published in the *American Ephemeris* will be reproduced. These satellites are bright enough to be seen even through small telescopes and the changing of their relative positions from night to night will be a matter of interesting study for the amateur.

## PLANET NOTES FOR FEBRUARY, 1920.

The *sun* will follow a northeasterly course through the constellation Aquarius during this month. At the end of the month it will be only 8 degrees south of the equator and almost directly north of the first magnitude star Fomalhaut.

The phases of the *moon* for this month are as follows:

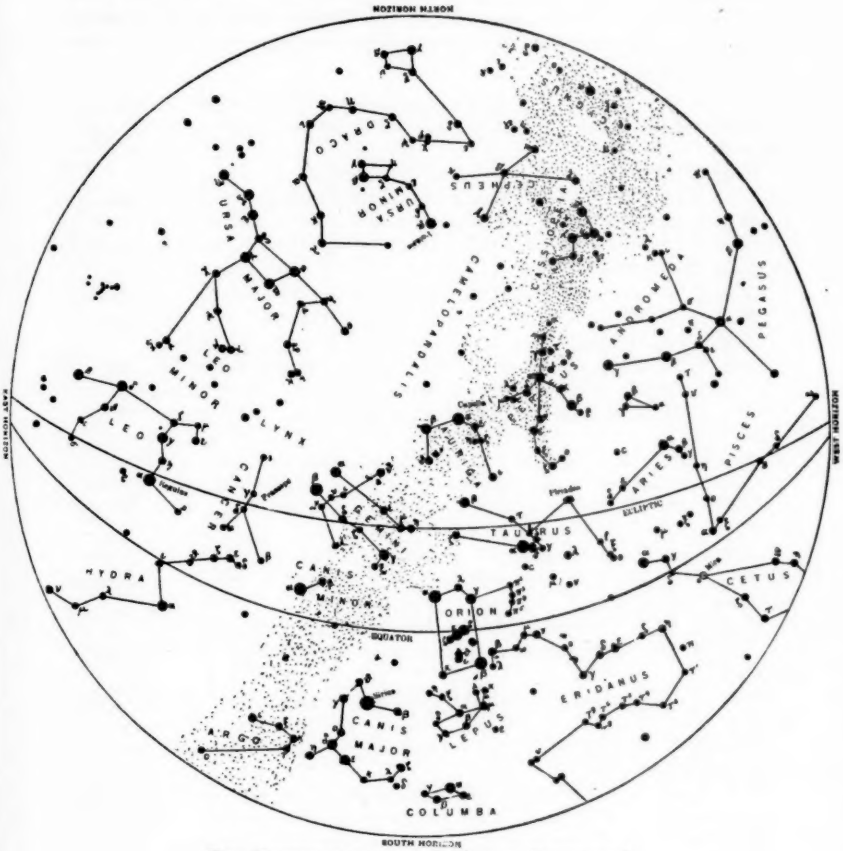
| | | | | | |
|---|---|---|---|---|---|
| Full Moon | Feb. 4 | at | 3:00 | P.M. | C.S.T. |
| Last Quarter | 11 | " | 3:00 | P.M. | " |
| New Moon | 19 | " | 4:00 | P.M. | " |
| First Quarter | 26 | " | 6:00 | P.M. | " |

*Mercury* will be in superior conjunction with the sun on February 5. It will, therefore, not be visible during the early part of the month. At the end of the month it will be approaching the position of greatest elongation east. As it will be several degrees north of the sun at this date it will be visible near the western horizon just after sunset.

*Venus* will still be visible during this month, although it will be rather low in the southeast just before sunrise. Its motion eastward is a little more rapid than that of the sun although it will not overtake the sun until July.

*Mars* during this month will be visible only late at night. At the end of the month it will rise about 9 o'clock in the evening. It is, however, 11 degrees south of the equator and consequently will not be particularly favorably situated for northern observers. It will be in the constellation Libra.

*Jupiter* will reach a point of opposition on February 2. It will, therefore, be very favorably situated for observation during this month. Its latitude of 18 degrees north will cause it to be very favorably located for northern observers. It will be slowly receding from the earth. It will be found in the constellation Leo, a short distance west of Regulus.




THE CONSTELLATIONS AT 9:00 P. M. FEBRUARY 1.

*Saturn* will reach a point of opposition on February 27, and will therefore be conspicuous in the eastern sky during the evening. It will be a short distance southeast of Regulus.

*Uranus* will be in conjunction with the sun on February 21, and will, therefore, be too near the sun to be observed during this month.

*Neptune* will be very near the planet Jupiter during this month, and may be observed with the telescope in the early evening.

**Occultations Visible in the United States, February, 1920.**

[NOTE:—Geographical positions are indicated by giving for each point, first the latitude, then the longitude, the two being separated by a dash. A line drawn on a map through the two or three points thus indicated will mark approximately the limit of the region of visibility.

The time given is the approximate Greenwich time of the middle of the occultation, as seen from the central longitude of that part of the U. S. where it is visible.]

Feb. 1, $0^h.5$ 71 Orionis, Mag. 5.1. Northwest of 38° — 124°, 49° — 110°.

Feb. 1, $19^h.5$. 110 B. Geminorum, Mag. 6.2. Northeast of 49° — 95°, 45° — 84° 40° — 74°.

Feb. 2, $16^h$. 1 Cancri, Mag. 6.0. Throughout the U. S.

Feb. 2, $22^h.5$. 30 B. Cancri, Mag. 6.1. Throughout the U. S. except Maine.

Feb. 3, $10^h.5$. $A^1$ Cancri, Mag. 5.5. Northwest of 44° — 80°, 38° — 76°.

Feb. 3, $12^h$. $A^2$ Cancri, Mag. 5.7. East of 49° —111°, 41° — 99°, and north of 41° — 99°, 44° — 81°, 45° — 66°.

Feb. 3, $16^h$. 60 Cancri, Mag. 5.7. North of 35° — 122°, 35° — 99°, 30° —80°.

Feb. 3, $17^h$. $\alpha$ Cancri, Mag. 4.3. South of 44° — 125°, 40° — 92°, 34° — 75°.

Feb. 3, $23^h$. $\kappa$ Cancri, Mag. 5.1. Throughout the U. S. except Maine.

Feb. 5, $1^h$. 14 Sextantis, Mag. 6.3. West of 28° — 85°, 38° — 80°, 49° — 76°.

Feb. 5, $22^h$. 237 B. Leonis, Mag. 6.3. Northeast of 46° — 78°, 42° — 70°.

Feb. 5, $23^h.5$. 55 Leonis, Mag. 6.1. Northeast of 49° — 115°, 40° — 99°, 33° — 76°.

Feb. 6, $3^h$. $p^3$ Leonis, Mag. 6.1. Northwest of 40° — 125°, 50° — 114°.

Feb. 6, $13^h$. 388 B. Leonis, Mag. 6.3. In Maine east of 70° longitude.

Feb. 6, $18^h$. 431 B. Leonis, Mag 6.2. Southwest of 50° — 105°, 45° — 87°, 40° — 74°.

Feb. 9, $1^h$. *i* Virginis, Mag. 5.7. North of 49° — 104°, 46° — 94°, 44° — 80°.

Feb. 9, $17^h.5$. 621 B. Virginis, Mag. 6.4. East of 48° — 90°, 43° — 87°, and northeast of 43° — 87°, 39° — 73°.

Feb. 11, $23^h.5$. $\lambda$ Libræ, Mag. 5.1. Throughout the U. S.

Feb. 14, $23^h$. 21 Sagittarii, Mag. 5.0. East of 50° — 104°, 40° — 108°, 28 — 105°.

Feb. 15, $23^h$. *d* Sagittarii, Mag. 5.0. East of 40° — 104°, 38° — 104° and north of 38° — 104°, 35° — 91°, 32° —80°.

Feb. 16, $2^h$. 45 Sagittarii, Mag. 6.0. South of 41° — 125°, 37° — 105°, and west of 37° — 105°, 28° — 100°.

Feb. 23, $14^h$. $\pi$ Piscium, Mag. 5.6. South of 38° — 126°, 40° — 105°, 37° —76°.

Feb. 25, $15^h$. 5. 26 B. Tauri, Mag. 6.4. Visible in Maine.

Feb. 26, $16^h$. 282 B. Tauri, Mag. 6.4. Throughout the U. S., except northern Maine.

Feb. 27, $14^h$. 372 B. Tauri, Mag. 6.1. South of 34° — 122°, 33° — 97°, 29° — 80°.

Feb. 28, $21^h$. 74 B. Geminorum, Mag. 6.2. West of 26° — 94°, 38° — 81°, 50° — 70°.

Feb. 29, $13^h$. 162 B. Geminorum, Mag. 5.7. South of 45° — 108°, 44° — 83°, 41° — 69°, and east of longitude 108°.

ARTHUR SNOW,
Ass't., Nautical Almanac Office, U. S. Naval Observatory.

## VARIABLE STARS.

### Minima of Variable Stars of Short Period.

[Calculated by members of the Class in General Astronomy in Carleton College.]

**Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5$^h$; Central Standard 6$^h$; etc.**

| Star | R. A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of minima in 1920 February |
|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h d h d h d h |
| SY Androm. | 0 08.0 | +43 09 | 9.5—13.0 | 34 21.8 | 14 11 |
| RT Sculptor. | 31.5 | −26 13 | 9.6—10.5 | 0 12.3 | 6 12; 14 4; 21 20; 28 13 |
| UU Androm. | 38.5 | +30 24 | 10.7—11.9 | 1 11.7 | 6 16; 14 13; 21 13; 28 13 |
| U Cephei | 0 53.4 | +81 20 | 7.0— 9.0 | 2 11.8 | 3 23; 11 11; 18 23; 26 11 |
| Z Persei | 2 33.7 | +41 46 | 9.4—12 | 3 01.4 | 6 1; 12 3; 18 6; 24 9 |
| TW Cassiop. | 37.6 | +65 19 | 8.2— 9.0 | 1 10.3 | 6 17; 13 20; 20 23; 28 3 |
| RY Persei | 39.0 | +47 43 | 8.0—10.3 | 6 20.7 | 7 8; 14 5; 21 1; 27 22 |
| RZ Cassiop. | 39.9 | +69 13 | 6.9— 8.1 | 1 04.7 | 1 9; 8 13; 15 17; 22 21 |
| TX Cassiop. | 44.4 | +62 22 | 9.4—10.1 | 2 22.2 | 7 13; 16 7; 25 2 |
| ST Persei | 53.7 | +38 47 | 8.5—10.5 | 2 15.6 | 1 21; 9 19; 17 18; 25 17 |
| RX Cassiop. | 2 58.8 | +67 11 | 8.6— 9.1 | 32 07.6 | 3 11 |
| Algol | 3 01.7 | +40 34 | 2.3— 3.5 | 2 20.8 | 1 2; 6 20; 18 7; 29 18 |
| RT Persei | 16.7 | +46 12 | 9.5—11.5 | 0 20.4 | 6 2; 12 21; 19 16; 26 11 |
| λ Tauri | 55.1 | +12 12 | 3.3— 4.2 | 3 22.9 | 5 16; 13 13; 21 11; 29 9 |
| RW Tauri | 3 57.8 | +27 51 | 7.1—<11 | 2 18.5 | 4 16; 12 23; 21 7; 29 14 |
| RV Persei | 4 04.2 | +33 59 | 9.5—11.0 | 1 23.4 | 8 10; 16 8; 24 5 |
| RW Persei | 13.3 | +42 04 | 8.8—11.0 | 13 04.8 | 12 12; 25 17 |
| SZ Tauri | 31.4 | +18 20 | 7.2— 7.7 | 3 03.6 | 8 16; 18 3; 27 13 |
| RS Cephei | 4 48.6 | +80 06 | 9.5—12.0 | 12 10.1 | 1 21; 14 7; 26 17 |
| TT Aurigae | 5 02.8 | +39 27 | 7.8— 8.7 | 0 16.0 | 2 18; 9 10; 16 2; 22 18 |
| RY Aurigae | 11.5 | +38 13 | 10.7—11.7 | 2 17.5 | 6 4; 14 8; 22 12 |
| RZ Aurigae | 42.9 | +31 40 | 10.6—13.3 | 3 00.3 | 2 15; 8 15; 20 16; 26 17 |
| SV Tauri | 45.8 | +28 05 | 9.4—11.0 | 2 04.0 | 3 9; 12 2; 20 17; 29 9 |
| Z Orionis | 50.2 | +13 40 | 9.7—10.7 | 5 04.9 | 10 10; 20 20 |
| SV Gemin. | 54.6 | +24 28 | 9.8—<11 | 4 00.2 | 1 22; 9 22; 16 23; 25 23 |
| RW Gemin. | 5 55.4 | +23 08 | 9.5—11.0 | 2 20.8 | 2 8; 8 2; 19 13; 25 7 |
| U Columbae | 6 11.2 | −33 03 | 9.2—10.0 | 2 19.2 | 4 20; 10 10; 21 15; 27 5 |
| SX Gemin. | 22.0 | +20 37 | 10.8—11.5 | 1 08.8 | 3 9; 11 13; 19 18; 27 23 |
| RW Monoc. | 29.3 | + 8 54 | 9.0—10.8 | 1 21.7 | 6 23; 14 14; 22 5; 29 20 |
| RX Gemin. | 43.6 | +33 21 | 8.8— 9.6 | 12 05.0 | 9 0; 22 5 |
| RU Monoc. | 6 49.4 | − 7 28 | 9.8—10.5 | 0 21.5 | 6 11; 13 15; 20 19; 27 23 |
| R Can. Maj. | 7 14.9 | −16 12 | 5.8— 6.4 | 1 03.3 | 7 8; 14 4; 20 23; 27 19 |
| RY Gemin. | 21.7 | +15 52 | 8.9—<10 | 9 07.2 | 3 16; 12 23; 22 6 |
| Y Camelop. | 27.6 | +76 17 | 9.5—12 | 3 07.3 | 7 3; 13 18; 20 8; 26 23 |
| TX Gemin. | 30.3 | +17 8 | 10.0—11.9 | 2 19.2 | 5 1; 13 10; 21 20 |
| RR Puppis | 43.5 | −41 08 | 9.4—10.7 | 6 10.3 | 3 16; 10 2; 22 22; 29 9 |
| V Puppis | 7 55.4 | −48 58 | 4.1— 4.8 | 1 10.9 | 4 1; 11 7; 18 14; 25 20 |
| X Carinae | 8 29.1 | −58 53 | 7.9— 8.7 | 0 13.0 | 6 9; 14 12; 22 15 |
| S Cancri | 8 38.2 | +19 24 | 8.2—10 | 9 11.6 | 4 22; 14 9; 23 21 |
| RX Hydrae | 9 00.8 | − 7 52 | 9.1—10.5 | 2 6.8 | 4 1; 10 21; 17 17; 24 13 |
| S Velorum | 29.4 | −44 46 | 7.8— 9.3 | 5 22.4 | 6 0; 11 22; 23 19; 29 17 |
| Y Leonis | 9 31.1 | +26 41 | 9.3—11.2 | 1 16.5 | 2 8; 9 2; 22 14; 29 8 |
| RR Velorum | 10 17.8 | −41 36 | 10.0—10.9 | 1 20.5 | 5 23; 13 9; 20 19; 28 5 |
| SS Carinae | 10 54.2 | −61 23 | 12.2—12.8 | 3 07.2 | 4 14; 11 5; 17 19; 24 9 |
| ST Urs. Maj. | 11 22.4 | +45 44 | 6.7— 7.2 | 8 19.2 | 1 5; 10 0; 18 19; 27 14 |
| RW Urs. Maj. | 35.4 | +52 34 | 10.3—11.4 | 7 07.9 | 3 9; 10 17; 18 1; 25 9 |
| Z Draconis | 11 39.8 | +72 49 | 9.9—13.6 | 1 08.6 | 4 2; 10 21; 17 16; 24 11 |
| RZ Centauri | 12 55.6 | −64 05 | 8.5— 8.9 | 1 21.0 | 7 11; 14 23; 22 12; 29 23 |
| RS Can. Ven. | 13 06.3 | +36 28 | 7.5—12.5 | 4 19.1 | 5 6; 14 21; 24 11 |
| SS Centauri | 13 07.2 | −63 37 | 8.8—10.4 | 2 11.5 | 1 17; 9 4; 16 14; 24 1 |
| *133926* Hydrae | 13 39.0 | −26 23 | 8.6—12.7 | 2 21.5 | 5 2; 10 21; 22 11; 28 6 |
| δ Librae | 14 55.6 | − 8 07 | 4.8— 6.2 | 2 07.9 | 1 14; 8 14; 22 13; 29 12 |

**Minima of Variable Stars of Short Period**—Continued.

| Star | R. A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of minima in 1920 February | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| U Coronae | 15 14.1 | +32 01 | 7.6— 8.7 | 3 10.9 | 6 7; | 13 5; | 20 2; | 27 0 | | | | |
| TW Draconis | 32.4 | +64 14 | 7.3— 8.9 | 2 19.3 | 3 12; | 11 22; | 20 8; | 28 18 | | | | |
| SS Librae | 15 43.4 | −15 14 | 9.3—11.5 | 0 18.4 | 1 0; | 8 16; | 16 8; | 24 0 | | | | |
| SW Ophiuchi | 16 11.1 | − 6 44 | 9.2—10.0 | 2 10.7 | 5 20; | 13 4; | 20 12; | 27 21 | | | | |
| SX Ophiuchi | 12.6 | − 6 25 | 10.5—11.2 | 2 01.5 | 1 18; | 10 0; | 18 6; | 26 12 | | | | |
| R Arae | 31.1 | −56 48 | 6.8— 7.9 | 4 10.2 | 7 3; | 15 23; | 24 20 | | | | | |
| TT Herculis | 16 49.9 | +17 00 | 8.9— 9.3 | 20 18.1 | 1 17; | 11 10; | 22 11 | | | | | |
| TU Herculis | 17 09.8 | +30 50 | 9.5—12 | 2 06.4 | 4 2; | 10 21; | 17 17; | 24 12 | | | | |
| U Ophiuchi | 11.5 | + 1 19 | 6.0— 6.7 | 0 20.1 | 9 8; | 17 17; | 26 2 | | | | | |
| *u* Herculis | 13.6 | +33 12 | 4.6— 5.4 | 2 01.2 | 6 7; | 12 11; | 18 15; | 24 18 | | | | |
| TX Herculis | 15.4 | +42 00 | 8.3— 9.0 | 1 00.7 | 2 20; | 9 0; | 21 8; | 27 13 | | | | |
| RV Ophiuchi | 29.8 | + 7 19 | 9. —12 | 3 16.5 | 5 7; | 12 16; | 20 1; | 27 10 | | | | |
| SZ Herculis | 36.0 | +33 01 | 9.5—10.3 | 0 19.6 | 1 15; | 9 19; | 17 23; | 26 4 | | | | |
| TX Scorpii | 48.6 | −34 13 | 7.5— 8.2 | 0 22.6 | 7 13; | 14 14; | 22 5; | 29 18 | | | | |
| UX Herculis | 49.7 | +16 57 | 8.8—10.5 | 1 13.2 | 1 3; | 8 21; | 16 15; | 24 9 | | | | |
| Z Herculis | 53.6 | +15 09 | 7.1— 7.9 | 3 23.8 | 6 13; | 14 12; | 22 12 | | | | | |
| WX Sagittae | 53.6 | −17 24 | 9.2—10.8 | 2 03.1 | 3 6; | 11 19; | 20 7; | 28 19 | | | | |
| WY Sagittae | 17 54.9 | −23 1 | 9.5—10.6 | 4 16.0 | 2 3; | 11 11; | 20 19 | | | | | |
| SX Draconis | 18 03.0 | +58 23 | 9.3—10.5 | 5 04.1 | 8 20; | 19 4; | 29 12 | | | | | |
| RS Sagittarii | 11.0 | −34 08 | 5.9— 6.3 | 2 10.0 | 7 0; | 14 6; | 21 12; | 28 18 | | | | |
| V Serpentis | 11.1 | −15 34 | 9.5—11.1 | 3 10.9 | 4 5; | 11 3; | 18 1; | 24 23 | | | | |
| RZ Scuti | 21.1 | − 9 15 | 7.4— 8.3 | 15 03.2 | 8 4 | | 23 9 | | | | | |
| RZ Draconis | 21.8 | +58 50 | 9.5—10.2 | 0 13.2 | 5 3; | 12 7; | 19 11; | 26 15 | | | | |
| RX Herculis | 26.0 | +12 32 | 7.0— 7.6 | 0 21.3 | 1 17; | 8 20; | 15 23; | 23 1 | | | | |
| SX Sagittarii | 39.7 | −30 36 | 8.7— 9.8 | 2 01.8 | 4 19; | 13 2; | 21 9; | 29 17 | | | | |
| RR Draconis | 40.8 | +62 34 | 9.3—13 | 2 19.9 | 5 10; | 13 22; | 22 10 | | | | | |
| RS Scuti | 43.7 | −10 21 | 9.3—10.3 | 0 15.9 | 5 4; | 11 19; | 18 11; | 25 2 | | | | |
| *β* Lyrae | 46.4 | +33 15 | 3.4— 4.1 | 12 21.8 | | 12 4; | 25 2 | | | | | |
| U Scuti | 18 48.9 | −12 44 | 9.1— 9.6 | 0 22.9 | 6 7; | 13 22; | 21 16 | | | | | |
| RX Draconis | 19 01.1 | +58 35 | 9.3—10.2 | 1 21.4 | 5 7; | 12 21; | 20 11; | 28 0 | | | | |
| RV Lyrae | 12.5 | +32 15 | 11. —12.8 | 3 14.4 | 4 13; | 11 18; | 18 23; | 26 3 | | | | |
| RS Vulpec. | 13.4 | +22 16 | 6.9— 8.0 | 4 11.4 | 6 8; | 15 7; | 24 6 | | | | | |
| U Sagittae | 14.4 | +19 26 | 6.5— 9.0 | 3 09.1 | 1 20; | 8 13; | 22 3; | 28 21 | | | | |
| Z Vulpec. | 17.5 | +25 23 | 7.3— 8.5 | 2 10.9 | 4 16; | 12 0; | 19 9; | 26 18 | | | | |
| TT Lyrae | 24.3 | +41 30 | 9.4—11.6 | 5 05.8 | 5 4; | 10 10; | 20 22; | 26 4 | | | | |
| UZ Draconis | 26.1 | +68 44 | 9.0— 9.8 | 1 15.1 | 2 20; | 9 9; | 22 10; | 28 22 | | | | |
| SY Cygni | 19 42.7 | +32 28 | 10 —12 | 6 00.2 | 1 23; | 7 23; | 20 0; | 26 0 | | | | |
| WW Cygni | 20 00.6 | +41 18 | 9.3—13.4 | 3 07.6 | 4 7; | 10 23; | 17 14; | 24 5 | | | | |
| SW Cygni | 03.8 | +46 01 | 9. —11.7 | 4 13.8 | 9 9; | 18 13; | 27 16 | | | | | |
| VW Cygni | 11.4 | +34 12 | 9.8—11.8 | 8 10.3 | 4 11; | 12 21; | 21 7 | | | | | |
| RW Capric. | 12.2 | −17 59 | 8.8—10.6 | 3 09.4 | 2 7; | 9 2; | 15 21; | 22 16 | | | | |
| UW Cygni | 19.6 | +42 55 | 10.5—13 | 3 10.8 | 6 2; | 12 23; | 19 21; | 26 19 | | | | |
| V Vulpec. | 32.3 | +26 15 | 8.2— 9.8 | 37 19.0 | | | 27 20 | | | | | |
| W Delphini | 33.1 | +17 56 | 9.4—12.1 | 4 19.4 | 5 6; | 14 21; | 24 12 | | | | | |
| RR Delphini | 38.9 | +13 35 | 10.5—11.8 | 4 14.4 | 9 4; | 18 9; | 27 13 | | | | | |
| Y Cygni | 48.1 | +34 17 | 7.1— 7.9 | 1 12.0 | 7 7; | 14 19; | 22 7; | 29 18 | | | | |
| WZ Cygni | 49.3 | +38 27 | 9.9—10.8 | 0 14.0 | 8 8; | 15 22; | 23 13 | | | | | |
| RR Vulpec. | 20 50.5 | +27 32 | 9.6—11.0 | 5 01.2 | 3 0; | 13 2; | 23 5 | | | | | |
| VV Cygni | 21 02.3 | +45 23 | 12.1—13.8 | 1 11.4 | 4 0; | 11 0; | 18 19; | 26 4 | | | | |
| AE Cygni | 09.0 | +30 20 | 10.8—11.4 | 0 23.3 | 7 18; | 17 11; | 27 3 | | | | | |
| RY Aquarii | 14.8 | −11 14 | 8.8—10.4 | 1 23.2 | 5 14; | 13 11; | 21 8; | 29 5 | | | | |
| RT Lacertae | 21 57.4 | +43 24 | 9.1—10.5 | 5 01.7 | 1 11; | 11 14; | 21 17 | | | | | |
| UZ Cygni | 55.2 | +43 52 | 8.9—11.6 | 31 07.3 | | | 25 5 | | | | | |
| RW Lacertae | 22 40.6 | +49 08 | 10.2—11.2 | 5 04.4 | 4 9; | 14 18; | 19 23; | 25 3 | | | | |
| TT Androm. | 23 08.7 | +45 36 | 11.3—12.6 | 2 18.4 | 3 14; | 11 21; | 20 5; | 28 11 | | | | |
| Y Piscium | 29.3 | + 7 22 | 9.0—12.0 | 3 18.3 | 3 12; | 11 1; | 18 13; | 24 2 | | | | |
| TW Androm. | 23 58.2 | +32 17 | 8.6—11.5 | 4 02.9 | 8 19; | 17 1; | 25 7 | | | | | |

## Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

| Star | R. A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of maxima in 1920. February |
|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h d h d h d h |
| SX Cassiop. | 0 05.5 | +54 20 | 8.6— 9.2 | 36 13.7 | 18 11 |
| SY Cassiop. | 0 09.8 | +57 52 | 9.3— 9.9 | 4 1.7 | 9 1; 17 4; 25 7 |
| RR Ceti | 1 27.0 | + 0 50 | 8.3— 9.0 | 0 13.3 | 7 12; 15 6; 23 0 |
| RW Cassiop. | 130.7 | +57 15 | 8.9—11.0 | 14 19.2 | 5 22 20 17 |
| V Arietis | 2 09.6 | +11 46 | 8.3— 9.0 | 0 23.8 | 7 2; 15 1; 23 23 |
| SU Cassiop. | 2 43.0 | +68 28 | 6.5— 7.0 | 1 22.8 | 3 14; 11 9; 19 5; 27 0 |
| TU Persei | 3 01.8 | +52 49 | 11.4—12.2 | 0 14.6 | 4 7; 11 14; 18 21; 26 4 |
| RW Camelop. | 3 46.2 | +58 21 | 8.2— 9.4 | 16 00.0 | 14 |
| SX Persei | 4 10.2 | +41 27 | 10.4—11.2 | 4 07.0 | 3 16; 12 6; 20 19; 29 9 |
| SV Persei | 42.8 | +42 07 | 8.8— 9.6 | 11 03.1 | 5 7; 16 11; 27 14 |
| RX Aurigae | 4 54.5 | +39 49 | 7.2— 8.1 | 11 15.0 | 6 12; 18 3; 29 18 |
| SX Aurigae | 5 04.6 | +42 02 | 8.0— 8.7 | 1 12.8 | 1 9; 9 1; 16 17; 24 9 |
| SY Aurigae | 05.5 | +42 41 | 8.4— 9.5 | 10 03.3 | 9 15; 19 18; 29 22 |
| Y Aurigae | 21.5 | +42 21 | 8.6— 9.6 | 3 20.6 | 4 3; 11 20; 19 13; 27 7 |
| RZ Gemin. | 5 56.6 | +22 15 | 9.1—10.0 | 5 12.7 | 5 20; 11 9; 22 11; 27 23 |
| RS Orionis | 6 16.5 | +14 44 | 8.2— 8.9 | 7 13.6 | 5 13; 13 3; 20 16; 29 6 |
| T Monoc. | 19.8 | + 7 08 | 5.7— 6.8 | 27 00.3 | 1 9 28 9 |
| RT Aurigae | 23.0 | +30 33 | 5.1— 6.0 | 3 17.5 | 7 12; 15 9; 22 20; |
| RZ Camelop. | 23.7 | +67 06 | 11.0—13.0 | 0 11.5 | 2 5; 9 10; 16 15; 23 20 |
| W Gemin. | 29.2 | +15 24 | 6.7— 7.5 | 7 22.0 | 6 20; 14 18; 22 16 |
| ζ Gemin. | 6 58.2 | +20 43 | 3.7— 4.3 | 10 03.7 | 3 3; 13 6; 23 10 |
| RU Camelop. | 7 10.9 | +69 51 | 8.5— 9.8 | 22 06.5 | 8 3 |
| RR Gemin. | 7 15.2 | +31 04 | 10.0—11.5 | 0 09.5 | 6 11; 14 10; 22 9 |
| V Carinae | 8 26.7 | −59 47 | 7.4— 8.1 | 6 16.7 | 2 22; 9 15; 16 7; 23 0 |
| T Velorum | 8 34.4 | −47 01 | 7.6— 8.5 | 4 15.3 | 7 0; 16 6; 25 13 |
| V Velorum | 9 19.2 | −55 32 | 7.5— 8.2 | 4 08.9 | 1 0; 9 18; 18 12; 27 6 |
| Z Leonis | 9 46.4 | +27 22 | 7.9— 9.6 | 59 00.0 | 13 0 |
| RR Leonis | 10 02.1 | +24 29 | 9.1—10.1 | 0 10.9 | 1 19; 8 14; 22 3; 28 22 |
| SU Draconis | 11 32.2 | +67 53 | 8.9— 9.6 | 0 15.8 | 3 15; 10 5; 16 20; 23 10 |
| S Muscae | 12 07.4 | −69 36 | 6.4— 7.3 | 9 15.8 | 3 20; 13 12; 23 4 |
| SW Draconis | 12.8 | +70 04 | 8.8— 9.6 | 0 13.7 | 6 8; 14 7; 22 7 |
| T Crucis | 15.9 | −61 44 | 6.8— 7.6 | 6 17.6 | 4 16; 11 10; 18 4; 24 21 |
| R Crucis | 18.1 | −61 04 | 6.8— 7.9 | 5 19.8 | 5 21; 11 17; 17 13; 23 9 |
| S Crucis | 12 48.4 | −57 53 | 6.5— 7.6 | 4 16.6 | 2 5; 6 22; 16 7; 21 0 |
| W Virginis | 13 20.9 | − 2 52 | 8.7—10.4 | 17 06.5 | 7 19 25 2 |
| SS Hydrae | 25.0 | −23 08 | 7.4— 8.1 | 8 4.8 | 1 5; 9 10; 17 15; 25 20 |
| RV Urs. Maj. | 13 29.4 | +54 31 | 9.2— 9.9 | 0 11.2 | 6 19; 13 20; 20 20; 27 21 |
| ST Virginis | 14 22.5 | − 0 27 | 10.3—11.4 | 0 09.9 | 8 19; 17 0; 25 6 |
| V Centauri | 25.4 | −56 27 | 6.4— 7.8 | 5 11.9 | 4 22; 10 10; 21 10; 26 22 |
| RS Bootis | 29.3 | +32 11 | 8.9—10.0 | 0 09.1 | 8 3; 15 16; 23 5 |
| RU Bootis | 14 41.5 | +23 44 | 12.8—14.3 | 0 11.9 | 3 4; 10 14; 18 0; 25 10 |
| R Triang. Austr. | 15 10.8 | −66 08 | 6.7— 7.4 | 3 09.3 | 1 2; 7 21; 21 11; 28 5 |
| S Triang. Austr. | 15 52.2 | −63 29 | 6.4— 7.4 | 6 07.8 | 3 5; 9 13; 22 4; 28 12 |
| S Normae | 16 10.6 | −57 39 | 6.6— 7.6 | 9 18.1 | 8 8; 18 2; 27 20 |
| RW Draconis | 33.7 | +58 03 | 9.6—10.8 | 0 10.6 | 4 8; 13 5; 22 1 |
| RV Scorpii | 16 51.8 | −33 27 | 6.7— 7.4 | 6 01.5 | 6 7; 12 9; 18 10; 24 12 |
| X Sagittarii | 17 41.3 | −27 48 | 4.4— 5.0 | 7 00.3 | 5 5; 13 5; 20 5; 27 5 |
| Y Ophiuchi | 47.3 | − 6 07 | 6.1— 6.5 | 17 02.9 | 1 14 18 16 |
| W Sagittarii | 17 58.6 | −29 35 | 4.3— 5.1 | 7 14.3 | 4 23; 12 14; 20 4; 27 18 |
| Y Sagittarii | 18 15.5 | −18 54 | 5.4— 6.2 | 5 18.6 | 1 23; 7 18; 19 7; 25 2 |
| U Sagittarii | 26.0 | −19 12 | 6.5— 7.3 | 6 17.9 | 6 0; 12 18; 19 12; 26 5 |
| Y Scuti | 32.6 | − 8 27 | 8.7— 9.2 | 10 08.3 | 4 22; 15 6; 25 14 |
| Y Lyrae | 34 2 | +43 52 | 11.3—12.3 | 0 12.1 | 4 14; 10 16; 22 17; 28 18 |
| RZ Lyrae | 18 39.9 | +32 42 | 9.9—11.2 | 0 12.3 | 3 10; 9 13; 21 20; 27 23 |

**Maxima of Variable Stars of Short Period—Continued.**

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of maxima in 1920. February | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h |
| RT Scuti | 18 44.1 | −10 30 | 9.1— 9.7 | 0 11.9 | 1 9; | 7 8; | 13 6; | 25 4 | | | |
| κ Pavonis | 18 46.6 | −67 22 | 3.8— 5.2 | 9 02.2 | 2 4; | 11 6; | 20 8, | 29 10 | | | |
| U Aquilae | 19 24.0 | − 7 15 | 6.2— 6.9 | 7 00.6 | 1 19; | 8 19; | 22 21; | 29 21 | | | |
| XZ Cygni | 30.4 | +56 10 | 8.6— 9.3 | 0 11.2 | 3 20; | 10 20; | 17 20; | 24 20 | | | |
| U Vulpec. | 32.2 | +20 07 | 6.5— 7.6 | 7 23.5 | 1 20; | 8 20; | 16 19; | 24 19 | | | |
| SU Cygni | 40.8 | +29 01 | 6.2— 7.0 | 3 20.3 | 8 5; | 15 22; | 23 14 | | | | |
| η Aquilae | 47.4 | + 0 45 | 3.7— 4.5 | 7 04.2 | 7 10; | 14 14; | 21 18; | 28 23 | | | |
| S Sagittae | 51.5 | +16 22 | 5.6— 6.4 | 8 09.2 | 5 7; | 13 15; | 22 2 | | | | |
| X Vulpec. | 19 53.3 | +26 17 | 9.5—10.5 | 6 07.7 | 6 7; | 12 15; | 19 22; | 25 6 | | | |
| X Cygni | 20 39.5 | +35 14 | 6.0— 7.0 | 16 09.3 | | 10 1 | | 26 10 | | | |
| T Vulpec. | 47.2 | +27 52 | 5.5— 6.1 | 4 10.5 | 2 6; | 11 3; | 19 23; | 29 21 | | | |
| WY Cygni | 52.3 | +30 03 | 9.6—10.4 | 0 13.5 | 4 18; | 11 12; | 18 5; | 24 23 | | | |
| RV Capric. | 55.9 | −15 37 | 9.2—10.1 | 0 10.7 | 1 0; | 7 17; | 21 3; | 27 20 | | | |
| TX Cygni | 20 56.4 | +42 12 | 8.5— 9.7 | 14 17.4 | 4 0 | | 18 18 | | | | |
| VY Cygni | 21 00.4 | +39 34 | 8.8— 9.5 | 7 20.6 | 4 17; | 12 13; | 20 10; | 28 7 | | | |
| SW Aquarii | 10.2 | — 0 20 | 9.9—10.8 | 0 11.0 | 4 14; | 11 11; | 18 9; | 25 6 | | | |
| VZ Cygni | 21 47.7 | +42 40 | 8.2— 9.2 | 4 20.7 | 3 5; | 12 23; | 22 16; | 27 13 | | | |
| Y Lacertae | 22 05.2 | +50 33 | 9.1— 9.6 | 4 07.8 | 1 9; | 10 1; | 18 18; | 27 9 | | | |
| δ Cephei | 25.5 | +57 54 | 3.7— 4.6 | 5 08.8 | 4 13; | 9 21; | 20 15; | 25 23 | | | |
| Z Lacertae | 36.9 | +56 18 | 8.2— 9.0 | 10 21.1 | 4 14; | 15 12; | 26 9 | | | | |
| RR Lacertae | 37.5 | +55 55 | 8.5— 9.2 | 6 10.1 | 1 2; | 10 12; | 20 8; | 26 18 | | | |
| V Lacertae | 44.5 | +55 48 | 8.5— 9.5 | 4 23.6 | 2 18; | 7 18; | 17 17; | 27 16 | | | |
| X Lacertae | 22 45.0 | +55 54 | 8.2— 8.6 | 5 10.7 | 3 11; | 8 21; | 19 19; | 25 5 | | | |
| SW Cassiop. | 23 03.7 | +58 11 | 9.2— 9.7 | 5 10.6 | 2 1; | 12 22; | 23 19; | 29 6 | | | |
| RS Cassiop. | 32.6 | +61 52 | 9.0—11.0 | 6 07.1 | 2 11; | 8 18; | 21 9; | 27 16 | | | |
| RY Cassiop. | 47.2 | +58 11 | 9.3—11.8 | 12 03.4 | 2 13; | 14 16; | 26 19 | | | | |
| V Cephei | 23 51.7 | +82 38 | 6.0—7.0 | 0 23.9 | 7 1; | 14 0; | 20 23; | 27 23 | | | |

## COMET AND ASTEROID NOTES.

**Comet *b* 1919 (Brorsen-Metcalf).**—This comet may be followed for some months yet by southern observers who have the use of large telescopes. The following ephemeris for January is by Mr. H. M. Jeffers of the Berkeley Astronomical Department, from elements which were given in *Lick Observatory Bulletin* 324:

EPHEMERIS FOR GREENWICH MIDNIGHT.

| 1920 | True α h m s | True δ ° ′ | log Δ | Br. |
|---|---|---|---|---|
| Jan. 2.5 | 14 33 17 | −30 16.2 | | |
| 4.5 | 35 39 | 30 45.6 | | |
| 6.5 | 37 54 | 31 14.4 | 0.2909 | 0.06 |
| 8.5 | 40 02 | 31 42.6 | | |
| 10.5 | 42 04 | 32 10.2 | | |
| 12.5 | 43 59 | 32 37.3 | | |
| 14.5 | 45 47 | 33 03.8 | 0.2964 | 0.05 |
| 16.5 | 47 29 | 33 29.8 | | |
| 18.5 | 49 03 | 33 55.3 | | |
| 20.5 | 50 30 | 34 20.4 | | |
| 22.5 | 51 50 | 34 45.0 | 0.2996 | 0.04 |
| 24.5 | 53 02 | 35 09.2 | | |
| 26.5 | 54 07 | 35 33.1 | | |
| 28.5 | 55 04 | 35 56.5 | | |
| Jan. 30.5 | 14 55 53 | −36 19.6 | 0.3024 | 0.04 |

Brightness November 3, 1919 = 1.00

**Elements of Comet *b* 1919 (Brorsen-Metcalf).**—Mr. F. E. Seagrave sends in the following elements of the Brorsen-Metcalf comet, based upon three observations by Professor E. E. Barnard, at Yerkes Observatory, on August 21, September 4 and September 16:

Epoch, Sept. 4.9338 G.M.T.

$M = 359° 25' 23''.03$
$\omega = 129 29 32.08$
$\Omega = 310 45 22.19$ 1919.0
$i = 19 12 49.31$

$\log a = 1.236749$
$\log e = 9.987618$
$\log q = 9.685574$
$\mu = 49''.5316$

These seem to make it certain that the period is about 72 years instead of the 42 years obtained by the Copenhagen computers.

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**Comet *c* 1919 (Metcalf-Borrelly).**—This comet is about two hours east and 10° south of the sun and so cannot be observed in northern latitudes. In the southern hemisphere it may be followed for several months. The following elements were computed by Mr. W. F. Meyer of the Berkeley Astronomical Department from observations on August 24, September 17 and October 22:

Elements of Comet *c* 1919.

$T = 1919$ Dec. 7.31400 G.M.T.

| | | | | | |
|---|---|---|---|---|---|
| $\omega$ | = 185° 45′ 44″.5 | | $\omega$ | = 185° 45′ 45″.0 | |
| $\Omega$ | = 120 59 04.5 | 1919.0 | $\Omega$ | = 120 59 54.4 | 1920.0 |
| $i$ | = 46 23 13.5 | | $i$ | = 46 23 13.2 | |

$\log q = 0.047229$

Constants for the Equator 1920.0

$x = r\,[9.894381] \sin (\ 46° 49' 09''.7 + v)$
$y = r\,[9.999005] \sin (313\ 44\ 45.2 + v)$
$z = r\,[9.795380] \sin (218\ 52\ 59.8 + v)$

The portion of the ephemeris given for January is as follows:

Ephemeris for Greenwich Mean Midnight.

| 1920 | True α h | m | s | True δ ° | ′ | ″ | log Δ | Br. |
|---|---|---|---|---|---|---|---|---|
| Jan. 2.5 | 20 | 47 | 56 | —33 | 09 | 05 | | |
| 4.5 | 20 | 57 | 19 | 33 | 26 | 43 | 0.2960 | 2.33 |
| 6.5 | 21 | 06 | 42 | 33 | 41 | 39 | | |
| 8.5 | 21 | 16 | 05 | 33 | 53 | 55 | | |
| 10.5 | 21 | 25 | 27 | 34 | 03 | 34 | | |
| 12.5 | 21 | 34 | 48 | —34 | 10 | 37 | 0.3048 | 2.05 |

Brightness September 17, 1919 = 1.00

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**Ephemeris of Comet *c* 1919 (Metcalf-Borrelly).**

Based upon Gallo's elements.

| G. Midnight 1920 | α h | m | s | δ ° | ′ | ″ | log r | log Δ |
|---|---|---|---|---|---|---|---|---|
| Jan. 4 | 20 | 59 | 49 | —33 | 39 | 17 | 0.07843 | 0.29265 |
| 8 | 21 | 18 | 46 | 34 | 05 | 26 | 0.08775 | 0.29686 |
| 12 | 21 | 37 | 39 | 34 | 20 | 56 | 0.09781 | 0.30153 |
| 16 | 21 | 56 | 22 | 34 | 25 | 58 | 0.01839 | 0.30660 |
| 20 | 22 | 14 | 48 | 34 | 21 | 06 | 0.11943 | 0.31211 |
| 24 | 22 | 32 | 54 | 34 | 07 | 12 | 0.13079 | 0.31799 |
| 28 | 22 | 50 | 33 | —33 | 44 | 56 | 0.14239 | 0.32425 |

F. E. Seagrave.

Boston, Dec. 5, 1919.

**Elements of Comet *d* 1919 (Finlay-Sasaki).**—The following elements of Comet *d* 1919 were calculated by Professor R. T. Crawford and Misses Priscilla Fairfield and Edith E. Cummings of the Berkeley Astronomical Department and were published in the *Lick Observatory Bulletin* 325. They were derived by assuming a period of 6.688 years and differentially correcting Fayet's elements of Finlay's Periodic Comet so as to represent Observations by Fayet at Nice on November 9, and by Jeffers at Lick Observatory on November 12 and 15.

ELEMENTS OF COMET *d* 1919 (FINLAY-SASAKI).

$T$ = 1919 Oct. 15.52428 G.M.T.

$\omega$ = 318° 14′ 52″.0
$\Omega$ = 46 54 47.0 } 1919.0
$i$ = 3 23 22.2

$\log q$ = 0.005615
$\log e$ = 9.854081
$\log a$ = 0.550207
$\mu$ = 530″.514
Period = 6.68821 years

CONSTANTS FOR THE EQUATOR 1919.0

$x = r\,[9.999595] \sin(95° 06′ 38″.6 + v)$
$y = r\,[9.954614] \sin(6 18 16.7 + v)$
$z = r\,[9.639929] \sin(359 59 56.5 + v)$

## NOTES FOR OBSERVERS.

### Monthly Report of the American Association of Variable Star Observers, November, 1919.

The observations for November show many interesting features, such as the almost simultaneous rise of the two irregular variables, U Geminorum, 074922, and SS Aurigae, 060547, the maximum of the latter being remarkable for its unusual duration. Close watch should be kept of these stars, the next rise of SS Aurigae being due about January 10, and that of U Geminorum about February 13. Mr. McAteer's telegraphic notification of the rise of U Geminorum made many observations of it possible, and his list of observations also calls for notice, not only because of its creditable length but its distribution through practically every hour of Right Ascension.

Attention is called to the variability of the 10.1 comparison star on the field of U Lyrae, 191637, about half way between the 9.5 comparison star and the variable. The variability, discovered recently by Miss Mackie, appears to be of the Algol type, and observations, especially of a minimum, are very desirable.

Mr. Yalden calls attention to the fact that W. Heffer & Sons, Ltd., Cambridge, Eng., offer a set of Hagen—six series complete, at 3-3-0.

Members are again urged not to overlook the change of date for sending the monthly reports; they should reach Harvard Observatory by the 20th of each month.

The following committees have been appointed by the President:

Committee on Slides: S. I. Bailey, chairman; M. J. Jordan, S. C. Hunter, E. L. Gould.

Committee on Charts: D. B. Pickering, chairman; J. J. Cran, J. E. G. Yalden.

Committee on Telescopes: Annie J. Cannon, chairman; Anne S. Young, W. T. Olcott.

Committee on Nominations for 1920: C. T. Whitehorn, chairman; T. C. H. Bouton, C. Y. McAteer.

## Variable Star Observations, November, 1919.

Oct. 0 = 2422232 Nov. 0 = 2422263 Dec. 0 = 2422293

*001032*
S Sculptoris
J.D. Est.Obs.
242
2250.3 9.2 $Tp_3$
55.7 8.9 Tp

001046
X Androm.
2278.7 12.9 E

001726
T Androm.
2246.3 11.6 Pe
77.6<12.9 Pi
87.6<10.7 Jd

001755
T Cassiop.
2246.2 8.5 Pe
51.3 8.6 L
79.5 8.8 M

001838
R Androm.
2248.7 7.5 $Pe_2$
63.3 7.4 Pe
65.6 7.8 Wh
75.6 7.7 Pt
76.6 8.9 V
78.6 7.3 Hu
87.8 8.0 M

*001909*
S Ceti
2279.6<11.5 M

*002438a*
T Sculptoris
2251.6 12.6 $Tp_2$
55.7 12.8 Tp

*002546*
T Phoenicis
2250.6 11.1 $Tp_2$
55.7 11.3 Tp

003179
Y Cephei
2265.5<12.0 K
76.6 12.0 Hu

004047
U Cassiop.
2246.2 12.3 Pe
77.5<12.8 Y

004132
RW Androm.
2278.7<13.2 E

004435
V Androm.
2278.7<13.0 E

004533
RR Androm.
J.D. Est.Obs.
242
2278.7<12.6 E

004746
RV Cassiop.
2278.7<14.0 E

004958
W Cassiop.
2265.6 9.0 Wh
69.5 8.9 $K_2$
73.5 8.5 B
80.6 8.5 Hu
81.5 9.5 Pi
93.6 8.6 M

010102
Z Ceti
2277.5 11.8 Pi
78.5 12.0 B
79.6 11.8 Wh

010940
U Androm.
2278.7 12.0 E
81.5 12.1 K
81.5 12.3 Cl
81.5 12.2 B

011041
UZ Androm.
2278.7 11.1 E

011208
S Piscium.
2277.6<13.6 Y

011272
S Cassiop.
2283.6 12.3 Wh
85.8 12.5 M

011712
U Piscium
2277.6 11.5 Pi
78.6 10.5 Hu
78.7 11.0 E
79.6 11.1 Wh

012350
RZ Persei
2277.5<12.6 Y

012502
R Piscium
2277.5 11.6 Pi
77.6 12.1 Y
78.7 12.4 E
80.5 13.3 Hy

013238
RU Androm.
J.D. Est. Obs.
242
2265.6 12.3 Wh
78.7<13.0 E

013338
Y Androm.
2278.7 12.6 E

014958
X Cassiop.
2273.5 9.9 K
76.8 10.8 M
77.5 10.2 Y

015354
U Persei
2265.6 9.5 Wh
72.5 9.8 K
76.8 9.7 M
78.6 9.0 Hu

021024
R Arietis
2251.3 8.3 L
52.3 8.3 Pe
56.3 7.9
75.6 9.5 Pt
78.0 9.2 $Pi_2$
78.5 9.4 Gd
78.6 9.0 Cl
78.6 9.0 K
85.8 9.3 M
86.5 10.0 Hn

021143a
W Androm.
2265.6 11.4 Wh
81.5 12.0 Pi

021258
T Cassiop.
2278.6 9.0 Hu

021281
Z Cephei
2273.5<13.0 Do
83.5 13.1 B

*021403*
o Ceti
2232.4 4.9 Pe
50.2 5.7 $Pe_5$
50.4 5.5 L
63.3 6.5 Pe
71.6 6.5 Mu
76.6 7.2 Pt
77.5 7.0 Pi
78.6 6.9 Jk
79.6 7.2 M

o Ceti
J.D. Est. Obs.
242
2280.0 6.9 $Mu_3$
80.6 6.3 Hu
80.6 6.7 Su
80.6 7.0 Wh
80.8 6.5 Hy
87.6 7.2 Mu
93.7 7.6 Wh

021558
S Persei
2278.6 8.7 Hu
93.7 9.2 M

*022000*
R Ceti
2246.3 9.6 Pe
79.6 11.0 M

022150
RR Persei
2277.5 11.2 Y
93.7 9.8 M

*022813*
U Ceti
2277.5 10.8 Pi
77.6 11.4 Y
77.6 10.1 B
79.6 11.2 M
93.6 11.8 Wh

022980
RR Cephei
2262.2<11.9 L

023133
R Trianguli
2277.6 6.5 Pi
79.6 6.4 M
80.6 6.2 Hu
83.6 6.1 B
86.6 6.3 Wh

024356
W Persei
2265.5 9.5 K
65.6 10.1 Wh
69.5 9.4 $Cl_2$
75.6 9.4 Pt
78.6 9.3 Hu
78.6 10.2 Pi
78.6 10.0 Gd
79.6 10.2 M
87.5 10.2 Gd
87.6 10.0 S

*025050*
R Horolog.
2251.6 12.7 $Tp_2$
55.7 12.8 Tp

*025751*
T Horolog.
J.D. Est.Obs.
242
2251.1 12.3 $Tp_2$
55.6 12.4 Tp

030514
U Arietis
2277.6<13.1 Y

*031401*
X Ceti
2277.5 10.8 Pi
77.6 10.5 B
79.6 10.3 M

032043
Y Persei
2248.4 9.6 $Pe_2$
72.5 9.3 K
75.6 9.6 Pt
77.5 8.5 Cl
78.6 8.6 Hu
81.5 8.7 Pi
93.7 9.0 M

032335
R Persei
2275.6 8.2 Pt
81.5 8.7 Pi
83.6 8.4 Wh
93.7 9.7 M

032443
Nova Persei #2
2250.4 13.0 Pe

033362
U Camelop.
2293.7 8.3 M

*035124*
T Eridani
2248.6 10.8 Tp
55.7 10.7

*040725*
W Eridani
2248.6 11.5 Tp

041619
T Tauri
2276.8 9.7 M

042209
R Tauri
2276.8 10.8 M
78.7 12.2 E
80.7 10.9 Wh
87.6 10.6 Y
90.3 10.2 $M_2$

VARIABLE STAR OBSERVATIONS, November, 1919—Continued.

042215
W Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | 9.9 | Pe |
| 73.6 | 9.4 | B |
| 73.6 | 9.6 | K |
| 76.8 | 9.6 | M |
| 77.6 | 10.4 | Jk |
| 78.1 | 10.2 | $Pi_2$ |
| 78.6 | 10.4 | Gd |
| 79.5 | 10.3 | K |
| 79.5 | 10.3 | Cl |
| 80.6 | 9.8 | Wh |
| 86.5 | 11.0 | Hn |
| 87.8 | 9.9 | M |

042309
S Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.7 | <13.8 | E |

043065
T Camelop.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.8 | <12.0 | M |

043208
RX Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.8 | 12.2 | M |
| 77.6 | 11.7 | B |

043274
X Camelop.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2266.8 | 11.6 | M |
| 78.5 | 11.4 | Y |
| 83.6 | 11.7 | Wh |

*043263*
R Reticuli

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.6 | 8.8 | Tp |
| 55.7 | 9.1 | |

*043562*
R Doradus

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.6 | 5.3 | Tp |
| 55.7 | 5.5 | |

*043738*
R Caeli

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2148.6 | 10.3 | Tp |
| 55.7 | 9.8 | |

044617
V Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 13.4 | B |
| 87.6 | <13. | Y |

045307
R Orionis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2275.8 | 11.5 | M |
| 78.6 | 11.7 | Y |
| 87.6 | 11.8 | B |

*045514*
R Leporis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2275.8 | 9.2 | M |
| 93.9 | 8.8 | Pt |

050003
V Orionis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | 10.5 | Y |
| 80.7 | 10.7 | Wh |
| 80.8 | 10.7 | M |
| 81.6 | 10.5 | B |
| 93.6 | 11.6 | Wh |

*050022*
T Leporis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2280.8 | 10.3 | M |

050953
R Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2279.6 | 11.4 | M |

*051247*
T Pict.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.7 | 9.7 | Tp |
| 55.7 | 9.4 | |

*051533*
T Columbae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2247.5 | 10.7 | Tp |
| 55.7 | 10.1 | |

052034
S Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | 9.4 | L |
| 79.6 | 9.1 | Pi |
| 79.6 | 8.9 | K |
| 79.6 | 9.1 | Cl |
| 79.6 | 9.0 | M |
| 81.6 | 8.9 | Wh |

*052404*
S Orionis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2279.7 | 12.0 | M |
| 87.6 | 12.6 | B |

*053005a*
T Orionis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | 10.0 | Pe |
| 75.8 | 10.0 | M |
| 78.6 | 10.0 | Gd |
| 78.6 | 10.0 | Pi |
| 81.6 | 9.5 | B |
| 82.7 | 9.7 | Wh |
| 87.6 | 10.4 | S |
| 87.6 | 10.4 | Gd |
| 93.6 | 10.2 | Wh |

053068
S Camelop.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2293.6 | 9.8 | M |

053326
RR Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 12.5 | B |
| 93.6 | 11.6 | M |

053531
U Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | 13.0 | Y |
| 87.6 | 11.2 | B |
| 93.6 | 11.4 | M |

054319
SU Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.4 | 9.4 | L |
| 76.7 | 9.5 | Wh |
| 77.6 | 9.4 | Y |
| 77.6 | 9.4 | Pi |
| 77.7 | 9.6 | E |
| 78.6 | 9.5 | B |
| 78.8 | 9.5 | E |
| 79.7 | 9.4 | M |
| 80.7 | 9.5 | E |
| 83.6 | 9.5 | B |
| 86.6 | 9.5 | |
| 87.6 | 9.4 | Pi |
| 90.7 | 9.6 | Wh |
| 94.6 | 9.5 | E |

054615a
Z Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | <13. | Y |

054615b
RS Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | 9.0 | Y |

054615c
RU Tauri

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | 11.6 | Y |

*054629*
R Columbae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2255.7 | <13.2 | Tp |

054920
U Orionis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 9.9 | Pi |
| 78.8 | 9.6 | E |
| 79.7 | 9.6 | M |
| 81.6 | 10.0 | B |
| 87.6 | 10.1 | Pi |

054974
V Camel.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | <12.8 | Y |

055353
Z Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 9.6 | B |
| 78.8 | 9.7 | E |
| 80.6 | 9.8 | $Pi_2$ |
| 88.6 | 9.8 | Y |
| 93.6 | 10.9 | M |

*055686*
R Octantis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2255.7 | 11.2 | Tp |

060450
X Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.6 | 10.3 | Pi |
| 78.8 | 10.4 | E |
| 81.7 | 10.3 | Wh |
| 87.7 | 9.3 | B |
| 93.7 | 8.8 | M |

060547
SS Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2252.3 | <11.5 | L |
| 77.6 | <12.4 | Y |
| 77.6 | <13.8 | B |
| 78.6 | <13.6 | K |
| 78.6 | <13.9 | B |
| 78.6 | <13.9 | Cl |
| 78.8 | <13.3 | E |
| 79.6 | <13.6 | B |
| 79.6 | <12.4 | M |
| 79.6 | <13.3 | Pi |
| 80.7 | 12.3 | E |
| 81.6 | 12.2 | K |
| 81.6 | 11.9 | B |
| 81.6 | 12.1 | Cl |
| 81.7 | 11.8 | E |
| 81.7 | 11.7 | Wh |
| 82.6 | 11.6 | |
| 82.6 | 11.4 | Y |
| 83.6 | 11.4 | B |
| 83.6 | 11.4 | Wh |
| 85.7 | 10.7 | E |
| 85.8 | 10.7 | M |
| 87.5 | 10.7 | B |
| 87.5 | 10.6 | Cl |
| 87.6 | 10.6 | Wh |
| 87.6 | 10.8 | Y |
| 87.6 | 11.0 | Jd |
| 87.6 | 10.9 | E |
| 87.6 | 10.7 | Pi |
| 87.7 | 10.7 | E |
| 87.8 | 10.6 | M |
| 90.7 | 11.2 | Wh |
| 93.6 | 12.0 | M |
| 93.7 | 11.9 | Wh |
| 94.6 | 12.9 | E |

061647
V Aurigae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 9.5 | B |
| 93.7 | 10.5 | M |

*061702*
V Monoc.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2279.6 | 9.5 | M |
| 87.8 | 10.3 | |

063159
U Lyncis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | <13. | Y |

063308
R Monoc.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2293.7 | 12.5 | M |

*065208*
X Monoc.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.8 | 7.5 | M |
| 93.7 | 8.4 | |

065355
R Lyncis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | <13.5 | Y |

070109
V Can. Min.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.8 | 8.6 | E |
| 87.8 | 9.1 | M |

070122a
R Gemin.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2253.4 | 8.7 | Pe |
| 76.7 | 6.6 | Pt |
| 79.7 | 7.0 | M |
| 87.6 | 7.0 | Pi |

070122b
Z Gemin.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2153.4 | 12.7 | Pe |
| 79.7 | 12.0 | M |

070122c
TW Gemin.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2253.4 | 8.8 | Pe |
| 79.7 | 8.5 | M |

070310
R Can. Min.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2287.6 | 11.0 | Pi |
| 87.8 | 10.2 | M |

*071044*
$L^2$ Puppis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2266.9 | 4.0 | Bh |
| 73.8 | 4.0 | |
| 76.9 | 4.1 | |
| 86.9 | 4.5 | |

071201
RR Monoc.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.8 | <13.0 | E |

071713

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.8 | 11.2 | E |
| 87.6 | <12.3 | Pi |

*072206*
Nova Monoc.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.9 | <12.2 | E |

072708
S Can. Min.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.8 | 9.5 | M |
| 78.8 | 9.8 | E |

072811
T Can. Min.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.8 | <13.7 | E |

VARIABLE STAR OBSERVATIONS, November, 1919—Continued.

*072820*b
Z Puppis
J.D. Est. Obs.
242
2278.8 9.2 E

073508
U Can. Min.
2278.8 11.0 E

073723
S Gemin.
2279.7 12.2 M
87.6<12.4 Pi

074323
T Gemin.
2279.7 9.5 M
83.7 10.5 Wh
87.6 10.6 Pi

074922
U Gemin.
2276.8<12.3 M
77.7<13.3 E
78.8<13.7
79.6<13.3 Pi
79.7<11.7 M
80.7<12.4 E
85.9 9.0 M
87.6 9.1 Y
87.6 9.5 Pi
87.6 9.4 Wh
87.7 9.7 E
87.8 9.4 M
90.7 9.4 Wh
92.8 9.7 M
93.7 10.3 Wh
93.7 9.8 M
94.6 10.6 E
95.8 11.1 M

075612
U Puppis
2285.9<11.8 M

081112
R Cancri
2287.8 10.5 M

081617
V Cancri
2292.8 8.2 M
93.9 8.5 Pt

*085008*
T Hydrae
2293.9 7.3 Pt

085120
T Cancri
2293.7 8.7 M

090425
W Cancri
2285.9 9.7 M

*091838*
RW Carinae
J.D. Est. Obs.
242
2255.7<13.2 Tp

*092962*
R Carinae
2255.7 4.7 Tp

*093014*
X Hydrae
2280.8 11.6 M

093178
Y Draconis
2278.6 13.0 Y
87.6 11.7

093934
R Leo. Min.
2280.8 10.7 M

094211
R Leonis
2280.8 10.3 M

*094262*
*l* Carinae
2255.7 3.5 Tp

*094622*
Y Hydrae
2293.9 7.0 Pt

095421
V Leonis
2180.8 11.8 M

*100661*
S Carinae
2255.7 6.3 Tp

103769
R Urs. Maj.
2280.9 12.4 M
85.9 12.1

*104620*
V Hydrae
2293.9 8.2 Pt

104814
W Leonis
2180.8<11.2 M

115919
R Com. Ber.
2285.9<12.2 M

122532
T Can. Ven.
2280.8 11.0 M

123160
T Urs. Maj.
J.D. Est. Obs.
242
2276.6 8.5 Jk
76.6 8.3 Do
80.8 8.7 M
87.5 8.3 Gd
93.9 8.8 Pt

123459
RS Urs. Maj.
2280.8<12.6 M

123961
S Urs. Maj.
2233.3 8.0 L
50.2 8.4
51.2 8.0 Pe
65.5 8.6 K
69.5 8.6 $Cl_2$
74.6 9.1 Pt
76.6 8.9 Do
77.5 9.1 Jk
80.8 9.0 M
87.5 9.1 Gd

134440
R Can. Ven.
2277.5 10.2 Y
85.9 10.6 M

*134677*
T Apodis
2254.6 13.6 Tp
54.6 13.4 δ

141954
S Bootis
2249.2 10.9 Pe
50.2 11.3 L
85.9<12.0 M

142539
V Bootis
2250.2 10.7 L
85.9 10.0 M

142584
R Camelop.
2283.6 13.2 B

144918
U Bootis
2185.9 11.0 M

151731
S Cor. Bor.
2277.5 11.8 Y

153378
S Urs. Min.
2276.5 8.6 V
79.6 8.4 Gd

154428
R Cor. Bor.
J.D. Est. Obs.
242
2246.2 6.0 Pe
46.3 5.9 L
49.2 5.9 Pe
51.2 6.0 L
62.2 5.9
65.5 6.2 M
71.6 6.3 Mu
74.6 6.2 Pt
76.5 6.1 Bh
76.6 6.5 Pt
77.6 6.5
79.5 6.1 Wh
80.6 6.1 Mu
82.6 6.1
83.6 6.4 Pt
86.5 6.1 Bh
86.5 6.1 Wh
93.5 6.1

154536
X Cor. Bor.
2265.5 9.8 M

154639
V Cor. Bor.
2265.5 8.0 M

160210
U Serpentis
2177.5<12.0 Y

161138
W Cor. Bor.
2277.5 9.0 Y

162119
U Herculis
2249.2 8.4 Pe
69.6 6.9 $Bh_2$
76.6 8.1 Pt

163137
W Herculis
2265.5<12.0 M
77.5 11.1 Jk
78.6 11.0 Hu

163266
R Draconis
2277.5 11.4 Jk
81.5 11.8 B
81.6 11.8 K
81.6 12.0 Cl

164055
S Draconis
2265.5 9.2 M
75.6 9.0 Pt
79.5 9.4 M

164715
S Herculis
J.D Est. Obs
242
2272.5 10.6 K
79.5 10.8
79.5 10.8 Cl

165631
RV Herculis
2246.3<12.7 Pe
65.5<12.6 M

171723
RS Herculis
2249.3 9.6 Pe
72.6 8.9 Hu

172809
RU Ophiuchi
2277.5<11.8 Pi

173557
TY Draconis
2250.4 8.8 Pe

175458a
T Draconis
2277.5 12.4 Jk

175458b
UY Draconis
2277.5 10.8 Jk

175519
RY Herculis
2249.3 11.5 Pe
73.5 13.0 K
73.5 13.1 B
83.5 13.4 Do

*180363*
R Pavonis
2248.6 8.5 Tp

180531
T Herculis
2235.3 8.7 L
47.3 8.9 $L_2$
49.3 9.4 Pe
62.3 9.8 L
65.5 10.3 M
72.6 11.0 Hu
76.5<11.0 V

180565
W Draconis
2277.5 12.2 Jk

VARIABLE STAR OBSERVATIONS, November, 1919—Continued.

180911
Nova Ophiu. #4

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2273.5 | 9.1 | Y |
| 76.5 | 9.0 | V |
| 77.5 | 9.0 | Jk |
| 77.5 | 9.2 | Y |
| 78.5 | 8.9 | V |
| 81.5 | 9.1 | |
| 83.5 | 9.4 | Y |
| 85.5 | 9.1 | V |
| 87.5 | 9.4 | Jk |

181103
RY Ophiuchi

| | | |
|---|---|---|
| 2273.5 | 13.0 | Do |

181136
W Lyrae

| | | |
|---|---|---|
| 2238.3 | 9.7 | Pe |
| 50.4 | 8.7 | |
| 62.3 | 8.2 | L |
| 65.6 | 7.9 | M |
| 69.6 | 7.9 | Wh |
| 72.6 | 7.8 | Hu |
| 75.6 | 7.6 | Pt |
| 76.5 | 8.0 | Pi |
| 93.5 | 8.2 | Gd |

*182133*
RV Sagittarii

| | | |
|---|---|---|
| 2248.6 | 9.5 | Tp |

182224
SV Herculis

| | | |
|---|---|---|
| 2249.3 | 9.5 | Pe |
| 50.3 | 9.5 | L |
| 83.5 | 11.0 | Do |

182306
T Serpentis

| | | |
|---|---|---|
| 2277.5 | <12.1 | Pi |
| 87.5 | 12.5 | Cl |
| 87.5 | 12.4 | B |

183149
SV Draconis

| | | |
|---|---|---|
| 2277.5 | 7.8 | Y |

183225
RZ Herculis

| | | |
|---|---|---|
| 2277.5 | <12.2 | Y |

183308
X Ophiuchi

| | | |
|---|---|---|
| 2250.3 | 8.7 | L |
| 73.5 | 8.6 | K |
| 73.5 | 8.8 | B |
| 77.5 | 8.8 | Pi |

184134
RY Lyrae

| | | |
|---|---|---|
| 2272.6 | 11.5 | Hu |

*184205*
R Scuti

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2246.2 | 6.3 | Pe |
| 50.4 | 5.9 | L |
| 51.2 | 5.7 | Pe |
| 62.2 | 5.1 | L |
| 65.5 | 5.0 | M |
| 65.6 | 5.3 | Bh |
| 66.6 | 5.3 | Pt |
| 67.6 | 5.8 | Bh |
| 68.6 | 5.4 | Pt |
| 68.6 | 5.6 | Bh |
| 71.6 | 5.8 | Mu |
| 72.6 | 5.4 | Bh |
| 73.6 | 5.3 | |
| 74.6 | 5.5 | Pt |
| 74.6 | 5.0 | Su |
| 75.5 | 5.0 | Bh |
| 75.6 | 5.3 | Pt |
| 76.5 | 5.4 | Bh |
| 76.5 | 6.0 | Hn |
| 76.6 | 5.4 | Pt |
| 76.7 | 6.0 | Mu |
| 77.5 | 5.8 | Pi |
| 77.6 | 5.5 | Pt |
| 78.5 | 5.5 | Bn |
| 78.6 | 5.1 | Hu |
| 79.5 | 5.3 | M |
| 80.6 | 5.8 | Mu |
| 82.6 | 5.8 | |
| 83.6 | 5.5 | Pt |
| 83.6 | 5.9 | Su |
| 85.6 | 5.5 | Pt |
| 86.5 | 5.8 | Bh |
| 86.5 | 6.1 | Hn |
| 86.6 | 5.7 | Pt |
| 87.5 | 5.5 | Bn |
| 87.6 | 5.9 | Mu |
| 93.6 | 5.5 | Pt |

184243
RW Lyrae

| | | |
|---|---|---|
| 2265.6 | <12.3 | M |

184300
Nova Aquilae #3

| | | |
|---|---|---|
| 2246.3 | 7.5 | Pe |
| 55.3 | 7.6 | L |
| 65.5 | 7.7 | M |
| 65.6 | 7.1 | Bh |
| 66.6 | 7.2 | Pt |
| 68.6 | 7.3 | |
| 73.6 | 7.5 | Bh |
| 74.6 | 7.6 | Pt |
| 75.6 | 7.4 | |
| 76.5 | 7.6 | V |
| 76.5 | 7.6 | Bh |
| 76.6 | 7.5 | Pt |
| 77.5 | 8.0 | Cl |
| 77.6 | 7.4 | Pt |
| 81.5 | 7.7 | V |

Nova Aquilae #3

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2283.6 | 7.3 | Pt |
| 85.6 | 7.5 | |
| 86.6 | 7.7 | |
| 93.6 | 7.5 | |

185634
Z Lyrae

| | | |
|---|---|---|
| 2265.6 | <12.3 | M |

190529
V Lyrae

| | | |
|---|---|---|
| 2277.6 | <12.7 | Y |

*190818*
RX Sagittarii

| | | |
|---|---|---|
| 2278.5 | <12.4 | B |

*190819a*
RW Sagittarii

| | | |
|---|---|---|
| 2278.6 | 10.0 | B |

190925
S Lyrae

| | | |
|---|---|---|
| 2262.3 | <12.8 | L |
| 83.5 | 11.3 | B |
| 83.5 | 11.5 | Do |

190926
X Lyrae

| | | |
|---|---|---|
| 2265.6 | 9.2 | M |

190967
U Draconis

| | | |
|---|---|---|
| 2265.6 | <12.1 | M |
| 76.6 | 12.0 | Hu |

*191019*
R Sagittarii

| | | |
|---|---|---|
| 2247.7 | 11.3 | $Pe_2$ |

*191033*
RY Sagittarii

| | | |
|---|---|---|
| 2233.4 | 6.8 | L |
| 48.6 | 6.6 | Tp |
| 50.8 | 6.4 | L |
| 62.2 | 5.5 | |

*191124*
TY Sagittarii

| | | |
|---|---|---|
| 2248.6 | <13.5 | Tp |
| 54.6 | 13.6 | |
| 54.6 | 13.9 | δ |

*191133*
—Sagittarii

| | | |
|---|---|---|
| 2248.6 | 9.0 | Tp |

191350
TZ Cygni

| | | |
|---|---|---|
| 2265.6 | 10.7 | M |
| 77.6 | 10.8 | Y |

191637
U Lyrae

| | | |
|---|---|---|
| 2276.5 | 12.0 | Pi |

192928
TY Cygni

| | | |
|---|---|---|
| 2293.5 | 11.6 | M |

193311
RT Aquilae

| | | |
|---|---|---|
| 2281.5 | 8.6 | K |
| 81.5 | 8.5 | Cl |
| 81.6 | 8.6 | B |

193449
R Cygni

| | | |
|---|---|---|
| 2273 6 | <12.4 | E |
| 76.5 | 11.8 | Pi |
| 76.6 | 12.0 | Hu |
| 87.6 | 11.0 | Cl |
| 87.6 | 10.7 | B |
| 93.5 | 10.3 | M |

193509
RV Aquilae

| | | |
|---|---|---|
| 2278.6 | 10.0 | Wh |

193732
TT Cygni

| | | |
|---|---|---|
| 2265.6 | 8.2 | M |
| 76.6 | 7.3 | Hu |

194048
RT Cygni

| | | |
|---|---|---|
| 2265.6 | 11.5 | M |
| 76.5 | 11.1 | Pi |
| 76.6 | 10.4 | Wh |
| 76.6 | 10.3 | Hu |
| 87.6 | 8.9 | B |
| 87.6 | 9.1 | Cl |

194348
TU Cygni

| | | |
|---|---|---|
| 2265.6 | <12.4 | M |
| 87.6 | 13.4 | B |

194604
X Aquilae

| | | |
|---|---|---|
| 2265.6 | <12.3 | M |

194632
χ Cygni

| | | |
|---|---|---|
| 2248.6 | 12.3 | $Pe_3$ |
| 73.6 | 12.9 | K |
| 73.6 | 12.9 | B |
| 78.5 | 12.5 | Cl |
| 78.5 | 12.9 | K |
| 78.5 | 12.9 | B |
| 83.5 | 13.1 | Do |

*194659*
S Pavonis

| | | |
|---|---|---|
| 2248.6 | 6.8 | Tp |

*194929*
RR Sagittarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.6 | <13.3 | Tp |
| 54.6 | 12.9 | |
| 54.6 | 13.4 | δ |

195849
Z Cygni

| | | |
|---|---|---|
| 2276.5 | 12.7 | Pi |
| 87.6 | 12.5 | B |

200212
SY Aquilae

| | | |
|---|---|---|
| 2250.3 | <12.7 | L |

200357
S Cygni

| | | |
|---|---|---|
| 2281.6 | <13.2 | B |

200647
SV Cygni

| | | |
|---|---|---|
| 2265.6 | 8.6 | M |
| 76.5 | 9.2 | Pi |
| 76.6 | 8.5 | Hu |
| 77.5 | 8.0 | Gd |
| 78.6 | 8.4 | B |
| 80.8 | 7.6 | Hy |
| 87.6 | 8.0 | Gd |
| 87.6 | 8.0 | S |
| 87.6 | 8.4 | Ya |

200715a
S Aquilae

| | | |
|---|---|---|
| 2265.5 | 10.2 | M |
| 76.6 | 9.2 | Ya |
| 87.5 | 9.3 | Cl |
| 87.5 | 9.2 | B |
| 87.6 | 9.3 | Wh |

200715b
RW Aquilae

| | | |
|---|---|---|
| 2265.5 | 8.4 | M |
| 76.6 | 9.1 | Ya |
| 87.5 | 9.2 | Cl |
| 87.5 | 9.2 | B |
| 87.6 | 9.4 | Wh |

200812
RU Aquilae

| | | |
|---|---|---|
| 2265.6 | <11.6 | M |

*200822*
W Capricorni

| | | |
|---|---|---|
| 2277.5 | <11.6 | Y |

200916
R Sagittae

| | | |
|---|---|---|
| 2265.5 | 9.1 | M |
| 76.6 | 10.0 | Ya |
| 87.5 | 9.1 | Cl |
| 87.5 | 9.0 | B |
| 87.6 | 8.8 | Wh |

VARIABLE STAR OBSERVATIONS, November, 1919—Continued

200938
RS Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2238.3 | 8.2 | Pe |
| 56.3 | 8.3 | |
| 65.6 | 8.1 | M |
| 76.5 | 8.7 | Pi |
| 76.6 | 7.5 | Wh |
| 80.6 | 7.5 | Ya |
| 81.6 | 8.2 | Gd |
| 93.5 | 8.2 | |
| 93.6 | 8.6 | M |

201008
R Delphini

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.3 | <12.8 | L |

*201121*
RT Capricorni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2233.3 | 7.1 | L |
| 50.3 | 7.2 | |
| 76.6 | 8.1 | Pt |
| 87.5 | 7.2 | Ya |

201130
SX Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 8.2 | Y |
| 87.5 | 7.5 | B |
| 93.6 | 8.4 | M |

*201139*
RT Sagittarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2248.6 | 9.1 | Tp |

201647
U Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2252.3 | 7.9 | Pe |
| 65.6 | 7.1 | M |
| 65.6 | 7.4 | Ya |
| 75.6 | 7.7 | Pt |
| 76.6 | 7.5 | Ya |
| 76.6 | 6.9 | Wh |
| 77.5 | 7.8 | Gd |
| 80.8 | 7.6 | Hy |
| 86.5 | 7.8 | Pi |
| 93.5 | 7.8 | Gd |

*202240*
U Microscopii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2251.6 | 13.2 | $Tp_2$ |
| 54.6 | 13.2 | δ |

202539
RW Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.6 | 8.6 | M |
| 76.5 | 9.1 | Pi |
| 76.6 | 8.4 | Wh |
| 93.6 | 8.9 | M |

202817
Z Delphini

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2283.6 | 9.3 | B |

202946
SZ Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.5 | 9.8 | Cl |
| 65.5 | 9.7 | K |
| 65.6 | 9.6 | M |
| 76.5 | 9.4 | Pi |
| 76.6 | 8.8 | Wh |
| 76.6 | 9.6 | Hu |
| 78.6 | 9.3 | B |
| 83.6 | 9.9 | Ya |
| 86.5 | 9.5 | K |
| 86.5 | 9.4 | Cl |
| 93.5 | 9.1 | M |

202954
ST Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2287.6 | 13.5 | B |

203226
V Vulpeculae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.6 | 8.8 | M |
| 76.7 | 9.0 | Pt |
| 78.6 | 8.7 | Wh |

203816
S Delphini

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.5 | 8.9 | V |
| 77.6 | 9.6 | Wh |
| 78.6 | 8.9 | Hu |
| 78.6 | 8.9 | B |

*203905*
Y Aquarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | <13.0 | Pe |

204104
W Aquarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | <13.0 | Pe |

*204215*
U Capric.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.5 | 11.9 | Y |

204318
V Delphini

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.6 | <12.6 | B |

*204405*
T Aquarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.4 | <13.0 | Pe |
| 73.5 | 13.0 | Do |

*205627*
RR Capric.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.3 | 13.0 | $Tp_3$ |
| 54.6 | 12.9 | δ |

205923
R Vulpeculae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.6 | 12.0 | Hu |
| 78.5 | 12.5 | B |

*210116*
RS Capric.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2275.6 | 8.5 | Pt |
| 81.6 | 8.3 | Ya |
| 83.6 | 8.4 | Pi |

210129
TW Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | <13.0 | Y |

210868
T Cephei

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2251.3 | 8.7 | L |
| 76.6 | 8.2 | Pt |

211614
X Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | <13.5 | Y |

*212030*
S Micros.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2251.6 | 11.3 | $Tp_2$ |

213678
S Cephei

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2276.6 | 9.0 | Hu |
| 85.8 | 11.0 | M |

213753
RU Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.6 | 8.8 | M |
| 86.5 | 8.6 | Pi |
| 87.6 | 8.9 | Ya |

213843
SS Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.5 | 8.4 | K |
| 65.5 | 8.3 | Cl |
| 65.6 | 8.2 | Gd |
| 65.6 | 8.7 | B |
| 65.6 | 8.2 | M |
| 65.7 | 8.7 | Wh |
| 68.6 | 8.7 | Pt |
| 69.5 | 9.4 | Pi |
| 69.6 | 9.3 | Wh |
| 69.6 | 9.2 | Ya |
| 71.5 | 9.6 | Do |
| 72.5 | 10.4 | K |
| 72.5 | 11.2 | Cl |
| 72.5 | 10.2 | E |
| 72.6 | 10.9 | Hu |
| 72.6 | 10.5 | M |
| 72.6 | 10.4 | Pi |
| 72.6 | 11.0 | B |
| 73.5 | 11.4 | Cl |
| 73.6 | 11.1 | B |
| 73.6 | 10.9 | K |
| 73.6 | 11.0 | E |
| 76.5 | 11.7 | Pi |
| 76.6 | 11.7 | Hu |
| 76.6 | <11.3 | V |
| 76.6 | 12.1 | Do |
| 77.5 | 11.6 | Cl |

SS Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.5 | 11.4 | B |
| 77.6 | 11.1 | Y |
| 77.6 | 11.2 | E |
| 77.6 | 11.6 | Pi |
| 78.5 | 11.9 | Cl |
| 78.5 | 11.8 | Gd |
| 78.5 | 11.8 | Pi |
| 78.6 | 11.7 | Hu |
| 78.6 | 11.8 | K |
| 78.6 | 11.6 | B |
| 79.6 | 11.6 | |
| 79.6 | 11.7 | K |
| 79.6 | 11.6 | Cl |
| 79.6 | 11.9 | M |
| 80.5 | 11.7 | Pi |
| 80.6 | 11.7 | Hu |
| 80.7 | 11.4 | Hy |
| 81.5 | 11.8 | Gd |
| 81.6 | 11.7 | K |
| 81.6 | 11.6 | Cl |
| 81.6 | 11.7 | B |
| 82.6 | 11.5 | Y |
| 82.6 | 11.5 | B |
| 83.5 | 11.9 | Do |
| 83.6 | 11.8 | Pi |
| 86.5 | 11.6 | Jd |
| 86.5 | 11.6 | E |
| 86.5 | 11.8 | Pi |
| 86.6 | 11.9 | B |
| 87.5 | 11.8 | S |
| 87.5 | 11.8 | Gd |
| 87.5 | 11.7 | B |
| 87.5 | 11.5 | Cl |
| 87.6 | <10.9 | Jd |
| 87.6 | 11.8 | Pi |
| 91.5 | 11.6 | Cl |
| 93.4 | 11.7 | E |
| 93.5 | 11.4 | K |
| 93.5 | 11.5 | Cl |
| 93.5 | 11.5 | M |
| 93.5 | 11.8 | Gd |
| 93.7 | 11.7 | Wh |

213937
RV Cygni

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2272.6 | 7.9 | M |
| 75.7 | 7.8 | Pt |
| 76.6 | 7.2 | Hu |
| 78.6 | 7.4 | B |

*214247*
R Gruis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2254.6 | 14.3 | Tp |
| 54.6 | 14.3 | δ |

215605
V Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2287.6 | <13. | Y |

220412
T Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2251.3 | <12.7 | L |

*221948*
S Gruis

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.3 | 10.2 | $Tp_2$ |
| 55.7 | 10.3 | Tp |

222129
RV Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2287.6 | 12.5 | B |

222439
S Lacertae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2272.6 | 10.9 | M |
| 72.7 | 10.9 | Pi |
| 78.6 | 10.8 | B |
| 87.6 | 11.8 | Wh |
| 87.6 | 11.5 | Y |

*223462*
T Tucanae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2250.3 | 13.4 | $Tp_3$ |
| 54.3 | 13.4 | δ |

223841
R Lacertae

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2287.6 | 11.5 | Y |

*225120*
S Aquarii

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2277.6 | 10.3 | Y |
| 83.6 | <11.3 | Pi |

225914
RW Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2278.5 | 11.9 | Y |
| 78.6 | 12.7 | B |

230110
R Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2273.6 | 11.8 | E |
| 76.7 | 11.2 | Wh |
| 78.5 | 11.6 | Y |
| 93.4 | 11.6 | E |

230759
V Cassiop.

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2265.6 | 10.7 | Wh |
| 72.6 | 11.4 | M |
| 72.7 | 11.4 | Pi |
| 76.6 | <11.2 | V |
| 78.6 | 11.2 | Hu |

231425
W Pegasi

| J.D. 242 | Est. | Obs. |
|---|---|---|
| 2251.3 | 11.9 | L |
| 78.6 | 11.0 | Hu |

VARIABLE STAR OBSERVATIONS, November, 1919—Continued.

**231508**
**S Pegasi**

| J.D. | Est. | Obs |
|---|---|---|
| 242 | | |
| 2146.3 | 9.7 | Pe |
| 77.7 | 8.3 | B |
| 78.6 | 8.2 | Wh |

***232746***
**V Phoenicis**

| | | |
|---|---|---|
| 2247.6 | <13.4 | Tp |
| 54.6 | 13.0 | |
| 54.6 | 12.9 | δ |

**232848**
**Z Androm.**

| J.D | Est. | Obs. |
|---|---|---|
| 242 | | |
| 2273.5 | 9.3 | Do |

**233335**
**ST Androm.**

| | | |
|---|---|---|
| 2272.7 | 10.8 | Pi |
| 72.7 | 10.8 | M |
| 78.6 | 10.3 | Hu |
| 83.6 | 10.6 | Do |
| 87.6 | 10.2 | Wh |

***233815***
**R Aquarii**

| J.D. | Est. | Obs. |
|---|---|---|
| 242 | | |
| 2275.6 | 7.0 | Pt |
| 78.6 | 7.0 | Hu |
| 80.5 | 7.1 | Ya |
| 80.8 | 6.6 | Hy |
| 83.6 | 6.7 | B |
| 86.6 | 6.9 | |

**235053**
**RR Cassiop.**

| | | |
|---|---|---|
| 2272.7 | 11.7 | Pi |
| 72.7 | 11.6 | M |

***235150***
**R Phoenicis**

| J.D. | Est. | Obs. |
|---|---|---|
| 242 | | |
| 2251.1 | 11.0 | $Tp_2$ |
| 55.7 | 10.8 | Tp |

**235350**
**R Cassiop.**

| | | |
|---|---|---|
| 2272.7 | 10.0 | Pi |
| 72.7 | 10.1 | M |
| 83.6 | 10.6 | Pi |

**235525**
**Z Pegasi**

| | | |
|---|---|---|
| 2277.6 | 11.3 | Wh |

**235855**
**Y Cassiop.**

| J.D. | Est. | Obs. |
|---|---|---|
| 242 | | |
| 2272.7 | 10.3 | M |
| 76.6 | 10.2 | V |

**235939**
**SV Androm.**

| | | |
|---|---|---|
| 2272.7 | 10.4 | Pi |
| 72.7 | 10.2 | M |
| 83.5 | 9.5 | Y |
| 83.6 | 9.2 | Pi |
| 87.4 | 8.8 | Jk |

**No. of Observations: 881. No. of Stars Observed: 257. No. of Observers: 27.**

The Catalogue of Lantern Slides, so generously published by Mr. Barns, has been distributed. If any member fails to receive a copy, please advise Professor Bailey.

The following observers contributed to this report: Bouton, Brown, Bunch, Clement, Dawson, Miss Downer, Eaton, Godfrey, Hay, Henckel Hunter, Miss Jenkins, Jordan, Kimball, Lacchini, McAteer, Mundt, Peltier, de Perrot, Pickering, Suter, Miss Swartz, Tapia, Vrooman, Whitehorn, Yalden, and Miss Young.

HOWARD O. EATON, Recording Secretary.

## GENERAL NOTES.

**Professor Frank Schlesinger,** who has for several years been director of the Allegheny Observatory, has recently been elected director of the Yale Observatory. He has accepted the position and will take up his duties there some time next spring.

**Dr. Viktor Knorre,** who was for many years an observer at the Berlin Observatory died on August 25, 1919, at the age of 78. He came of a family long connected with astronomy. His grandfather was an observer at Dorpat and his father was director of the observatory at Nikolajew in South Russia.

**Astronomical Telegrams.**—Notice has reached us that the Harvard College Observatory has been officially designated as the Central Station in America for the transmission of astronomical telegrams to and from the Bureau Central International des Télégrammes Astronomique, established by the Union Astronomique Internationale at Uccle, Belgium, to commence operations Janu-

ary 1, 1920. By this arrangement, astronomers in America should send announcements of discoveries by prepaid telegram to Harvard, as heretofore. These will be cabled to Uccle, and distributed in the usual manner to subscribers in America. Announcements received at the Observatory by cable from Uccle will be similarly treated. Telegrams should be addressed "Harvard College Observatory, Cambridge, Mass.", and cablegrams, "Observatory, Boston". The Observatory will receive applications from those wishing to subscribe to the international telegraphic service.

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**The Orbits of Three Spectroscopic Binary Stars.**—In the *Publications of the Dominion Observatory,* Ottawa, Canada, Vol. II, Nos. 14, 15 and 16, Mr. W. E. Harper gives orbits determined from the Ottawa observations of the three spectroscopic binaries Boss 3511, 19 Lyncis and *h* Draconis. The positions, magnitudes and spectral types of these stars are as follows:

| Star | $\alpha$ 1900.0 | $\delta$ 1900.0 | Mag. | Type |
|---|---|---|---|---|
| Boss 3511 | $13^h\ 30^m$ | $+37°\ 42'$ | 5.3 ph. | F |
| 19 Lyncis | 7 14.7 | +55 28 | 5.61 v. | B8 |
| *h* Draconis | 16 56 | +65 16 | 5 3 ph. | F5 |

ELEMENTS

| Star | Boss 3511 | 19 Lyncis | *h* Draconis |
|---|---|---|---|
| $P$ = | 1.61100 days | 2.25960 days | 51.710 days |
| $e$ = | 0.054 | 0.076 | 0.128 |
| $\omega$ = | 199°.05 | 126°.11 | 329°.32 |
| $K$ = | 10.06 km | 104.43 km | 17.96 km |
| $\gamma$ = | +6.64 km | +7.37 km | −22.59 km |
| $T$ = | J.D. 2,417,018.020 | J.D. 2,419,031.632 | J.D. 2,414,813.75 |
| $a \sin i$ = | 222,500 km. | 3,235,400 km | 12,625,000 km |
| $\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$ = | 0.0002 ⊙ | 0.26 ⊙ | 0.03 ⊙ |

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**Eclipse Photographs Verify Einstein's Prediction.**—The following circular announcing the results of the measurements of the eclipse photographs of May 28-29, 1919, was received after the forms had been made up for the December issue of POPULAR ASTRONOMY.

"THE ROYAL SOCIETY. MEETING FOR DISCUSSION, NOVEMBER 6, 1919.

"A Joint Meeting of the Royal Society and the Royal Astronomical Society was held, as a "Meeting for Discussion," the subject being the results of the Observations obtained at the Total Solar Eclipse on May 29, 1919.

"The following Summary of the opening Paper was supplied:—

"Sir F. W. Dyson, F.R.S., A. S. Eddington, F.R.S., and C. Davidson. A Determination of the Deflection of Light by the Sun's Gravitational Field, from Observations made at the Total Eclipse of the Sun, 1919, May 29.

"The paper gives the results obtained in the expeditions to observe the solar eclipse of May 29, sent out by the Joint Permanent Eclipse Committee. Two expeditions were sent out—one to Principe, on the West Coast of Africa, the observers being Prof. Eddington and Mr. Cottingham; the second to Sobral, in North Brazil, the observers being Dr. Crommelin and Mr. Davidson. The observers at Principe had the astrographic object-glass of the Oxford University

Observatory, which they used stopped-down to 8 inches as a fixed horizontal telescope, into which the field of stars surrounding the sun was reflected from a 16-inch cœlostat. Similarly, the observers at Sobral employed the astrographic object-glass of the Royal Observatory, also stopped-down to 8 inches, and, in addition, a 4-inch lens of 19-feet focus, belonging to the Royal Irish Academy, supplied with light by an 8-inch cœlostat.

"Owing to the exceptional number of bright stars in the neighborhood of the sun, the conditions of this eclipse were specially favorable for the determination of a possible deflection of light, and the attention of the observers was concentrated on this special problem.

"Happily both expeditions were successful. At Principe, in spite of cloudy weather, a few photographs were obtained, from which the deflection at the sun's limb was found to be 1.64″.

"At Sobral a series of photographs with the astrographic object-glass, considered unsatisfactory on account of the distortion of the reflecting mirror, gave 0.93″ for the deflection at the sun's limb. A very good series of seven photographs, taken with the 4-inch object-glass, gave for the deflection 1.98″, with a probable error, judged from the accordance of the results of about 6 per cent.

"The following table gives the deflections observed, compared with those predicted by Einstein's theory (which gives 1.75″ at the sun's limb) :—

| | Displacement in R.A. | | Displacement in Dec. | |
|---|---|---|---|---|
| No of Star | Observed | Calculated | Observed | Calculated |
| | ″ | ″ | ″ | ″ |
| 11 | −.19 | −.22 | +.16 | +.02 |
| 5 | −.29 | −.31 | −.46 | −.43 |
| 4 | −.11 | −.10 | +.83 | +.74 |
| 3 | −.20 | −.12 | +1.00 | +.87 |
| 6 | −.10 | +.04 | +.57 | +.40 |
| 10 | −.08 | +.09 | +.35 | +.32 |
| 2 | +.95 | +.85 | −.27 | −.09 |

"It is concluded that the sun's gravitational field gives the deflection predicted by Einstein's generalized theory of relativity."

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**The Einstein Theory of Relativity.**—Since the displacement of stars around the sun during a total eclipse had been suggested as a test of the correctness of the Einstein theory of relativity, it might seem that now this theory has been established; and some of the most prominent physicists and mathematicians are accepting the conclusion and proclaiming this as the most important advance in celestial dynamics since Newton's enunciation of the law of gravitation. Others are withholding judgment, accepting the results of measurement of the eclipse photographs, but feeling that there may be some other explanation of the deflection of the stars than the bizarre one of the theory of relativity. (For a simple statement of the theory of relativity the reader is referred to the article by W. Carl Rufus in Popular Astronomy No. 253, March 1918, p. 160). The fact that the predicted shift of the spectrum lines, which should be almost 100 times as great as the probable error of the modern spectroscope, was not found by St. John in an extensive investigation at the Mount Wilson Observatory, still weighs heavily against the theory.

In the discussion at the Joint Eclipse Meeting of the Royal Society and the

Royal Astronomical Society in London on November 6, as reported in *The Observatory* for November, 1919, Dr. Silberstein said:

"The theory stands or falls on the correctness of the results of Evershed and St. John. It is unscientific to assert for the moment that the deflection, the reality of which I admit, is due to gravitation. . . . . The discovery made at the eclipse expedition, beautiful though it is, does not, in these circumstances, prove Einstein's theory. We owe it to that great man [pointing to Newton's portrait] to proceed very carefully in modifying or retouching his Law of Gravitation; this is by no means defending blind conservatism. The spectral shift required is perhaps 100 times, but certainly not less than 40 or 50 times, the error of modern measurement. The solar spectrum can, even in this country, be observed many times a year, and the matter can thus be decided without our having to wait years or centuries for another equally advantageous eclipse. If the shift remains unproved as at present the whole theory collapses, and the phenomenon just observed by the astronomers remains a fact awaiting to be accounted for in a different way."

Professor Eddington said: "This effect may be taken as proving Einstein's *law* rather than his theory. It is not affected by the failure to detect the displacement of Fraunhofer lines on the Sun. If this latter failure is confirmed it will not affect Einstein's law of gravitation, but it will affect the views on which the law is arrived at. The law is right, though the fundamental ideas underlying it may yet be questioned.

"The difference of the two laws may be expressed analytically as follows: Any particle or light-pulse moves so that the integral of $ds$ between two points of its path (in four dimensions) is stationary where

$$ds^2 = -(1-2m/r)^{-1}\,dr^2 - r^2\,d\theta^2 + (1-2m/r)\,dt^2 \quad \text{(Einstein's law)}.$$
$$ds^2 = -dr^2 - r^2\,d\theta^2 + (1-2m/r)\,dt^2 \quad \text{(Newton's law)}.$$

"These expressions are in polar coördinates for a particle of gravitational mass $m$. I think the second expression may be accepted as corresponding to Newton's law—at any rate it gives no motion of perihelion of Mercury and the half-deflection of light. What we have established is the necessity for the factor multiplying $dr$.

"One further point must be touched upon. Are we to attribute the displacement to the gravitational field and not to refracting matter around he Sun? The refractive index required to produce the result at a distance of 15′ from the Sun would be that given by gases at a pressure of 1/60 to 1/200 of an atmosphere. This is of too great a density considering the depth through which the light would have to pass."

The President of the Royal Society said: . . . . "The real interest of Einstein's theory lies not so much in his results as in the method by which he gets them. If his theory is right, it makes us take an entirely new view of gravitation. If it is sustained that Einstein's reasoning holds good—and it has survived two very severe tests in connection with the perihelion of Mercury and the present eclipse—then it is the result of one of the highest achievements of human thought. The weak point in the theory is the great difficulty in expressing it. It would seem that no one can understand the new law of gravitation without a thorough knowledge of the theory of invariants and of the calculus of variations.

"One other point of physical interest arises from this discussion. Light is

deflected in passing near large bodies of matter. This involves alterations in the electric and magnetic field. This, again, implies the existence of electric and magnetic forces outside matter—forces at present unknown, though some idea of their nature may be got from the results of this expedition."

The following remarks of Professor Lindemann are interesting especially as suggesting a means of further testing the question without waiting for a favorable eclipse:

"The method to which the President of the Royal Astronomical Society has alluded was evolved in order to test Einstein's theory without being forced to wait for an eclipse. Using dark-red filters, we found it easy to photograph stars in broad daylight fairly close to the Sun. Einstein's theory could be tested, of course, if stars quite close to the Sun were photographed. The chief desiderata for this are a clear sky and plates sensitive far into the infra-red. The scattering decreases with the fourth power of the wave-length, so that any means allowing us to increase the wave-length will be of the utmost advantage.

"As to the theory itself, I must confess that the fact that it is always presented from a purely mathematical point of view seems regrettable to a mere physicist. No doubt the present form is correct, and even elegant once one has become familiar with the notation. I cannot believe, however, that a profound physical truth cannot be clothed in simpler language. . . . ."

We have not heard from American astronomers and physicists in regard to their views on the subject, except through clippings from the New York newspapers, from which it is best not to quote. On the whole one would gather from these reports a spirit of conservatism, perhaps of slight antagonism—at any rate of reluctance to accept the Einstein theory as true.

The extreme view, on the other hand, is presented in the following closing words of one of the clippings:

"But this is not enough for Einstein and his school. They assert that light not only simulates the properties of matter but, is matter. They further say that there is no such thing as the ether, and that it is impossible ever to fix a stationary line or lines in space; in fact, that motion of matter through the ether is a phrase without meaning, and that mathematically space is limited but is not a fixed, unalterable thing, but is itself altered in character by matter passing through it.

"Further in explanation of a purely mathematical theory it is impossible to go in any reasonable amount of space. It remains to add merely that on this mathematical theory the deflection of the light from stars whose rays graze the sun should amount not to three-quarters of a second, but to one and three-quarters of a second of arc.

"That result has been shown to be correct from the recent observations, and thus far Einstein's theory of relativity has stood the supreme test. There may be room for compromise, but so far scientists now say he is justified in saying that there is no ether, no absolute dimension of space, and no absolute dimension of time. Space and time are relative terms, and are bound up with one another."

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**Betelgeuse.**—Mr. F. E. Seagrave calls attention to the brightness of Betelgeuse ($\alpha$ Orionis) at the present time. He says that it is now a half magnitude brighter than it was at a minimum in 1911, and that it is now brighter than it has been at any time since 1912.

**The Atomic Ether.**—Herr L. Zehnder, in the *Ber. Deut. Physikal. Ges.*, 1919, XXI. 118-125, puts forward a theory of an atomic ether, and Dr. J. F. Spencer in Vol. 116 of the *Journal of the Chemical Society* (July 1919) gives the following summary of it. The ether is supposed to be made up of spherical ether atoms which are very small in comparison with atoms of matter. They are completely elastic, and move with a velocity comparable with that of light. A sheath of ether atoms surrounds every material atom and molecule, and all matter is pervious to ether atoms, so that there is no such state as an ether vacuum. Differences in velocity of ether atoms constitute many of the physical phenomena; for example, electricity is nothing but the heat of the ether, and light, percussion of the ether. The electron is made up of a definite number of ether atoms with an increased heat content. The increase of mass of an electron with increase of velocity is attributed to the carrying of more ether atoms by the electron. This theory is examined in connection with several physical laws, and found not to be at variance with them. The hydrogen atom is supposed to be spherical, made up of a perfectly elastic nucleus surrounded by an imperfectly elastic ether sheath. (*The Journal of the British Astronomical Association, October*, 1919.)

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**Stationary *D* Lines of Sodium in the Spectra of $\beta$ Scorpii and $\delta$ Orionis.**—In the *Lick Observatory Bulletin* No. 326 Miss Mary Lea Heger gives the results of a study of the Sodium lines in the spectra of the two spectroscopic binary stars $\beta$ Scorpii and $\delta$ Orionis. These two stars were chosen as representative of the type of spectroscopic binary in which the H and K lines have been found to be stationary.

Miss Heger finds that in both these stars the sodium lines $D_1$ and $D_2$ are sharp and narrow on all the spectrograms and that they remain practically stationary during the period of the binary, agreeing with the H and K lines (calcium) in yielding a velocity which is equal to the velocity of the binary system and is also equal to the component of the solar motion in the direction of the star.

In the conclusion to her paper Miss Heger says:

"There seems to be no doubt as to the close relationship of the D lines of sodium and the H and K lines of calcium. In appearance and behavior they are entirely comparable. But with this relationship all the uncertainties attendant upon the problem of stationary H and K lines become equally applicable to the D lines. Do these lines remain absolutely stationary or do they oscillate slightly, or do both cases arise? And, further, how can we explain their peculiar behavior? Do sodium clouds similar to the hypothetical calcium clouds exist in space? The velocities given by the sodium lines certainly approximate very closely to a space velocity of zero. But in these slow-moving class B stars they approximate quite as closely to the velocity of the binary system. May we not then be equally justified in suspecting that the cause of the phenomenon lies within the system? The large accidental errors of observation and the consequent uncertainty of the results do not warrant any definite conclusions. At present we can only recognize the relation between the sodium and calcium lines, and with this new evidence seek an explanation which we believe will at the same time account for the peculiarity of both."

**The "Eagle" and the Nova.**—In introducing his discussion of "The Novæ" in his retiring address on October 29, 1919, the President of the British Astronomical Association (Harold Thomson, F.R.A.S.) related the following interesting anecdote:

"Some of you will remember the little story I told you some time ago, how on June 8, 1918, a great vessel was launched on the Tyne for our Navy by Mrs. Page, the wife of the American Ambassador, who named her the 'Eagle.' Just before the launch took place, I had been speaking to a friend about this occasion which was then looming in the distance, and he had suggested that if I wanted a subject for an address all I had to do was to discover a new star and say nothing about it, and then I could write what I liked concerning it and no one could contradict me. A few minutes later the 'Eagle' was launched and taken in tow by two tugs, one called 'George V' and the other the 'President'—a remarkable coincidence in view of the fact that this was probably the first time in history that the wife of the representative of the great American Republic launched one of His Majesty's ships. But stranger still, that very night I did pick up a new star as advised by my friend, and it was in the constellation of the Eagle. It would seem a pity not to complete the chain of events, and so I propose to speak to you tonight on a few interesting points in connection with Novae, the appearance of which constitutes one of the most extraordinary phenomena of nature."

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**Polarization of the Night Sky.**—It is well known that the night sky background, between the stars, is far from dark when the atmosphere seems most transparent, and there is no moonlight or twilight. In order to test the question as to whether or not this illumination of the sky at night is due to scattered sunlight, some very delicate experiments have recently been performed by Lord Rayleigh in England and Harold D. Babcock at the Mount Wilson Observatory, California. In both cases specially designed polariscopes were used in connection with photographic plates, to determine whether or not the night sky light is polarized as is sunlight which is scattered by atmospheric particles by day. Both observers found that the night sky shows much less polarization than the day sky. Mr. Babcock whose apparatus was the more sensitive, and whose sky conditions were the more favorable, says: " . . . . The total amount of polarized light shown is extremely small.

"Quantitative measures of the sensitiveness have not been made, but it is safe to say that we have not found more than 1 per cent of polarization in the background of the night sky."

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**Measures of the Star Cluster N. G. C. 663.**—In the *Astronomical Journal* No. 759 Miss Vera M. Gushee gives the results of measures of this cluster on four plates taken with the 40-inch telescope of the Yerkes Observatory, two in 1903 and two in 1916, after an interval of nearly 13 years. The coördinates of 430 stars were measured on the best plate, but the number was later reduced to 209. The resulting proper motions are very small, the majority of them being under 0″.010 per year. A list is appended of 21 BD. stars within 15′ of the center of the cluster, the positions of 12 of which are given in the Astronomische Gesellschaft Catalogue.

The position for 1916.0 of the center of the cluster, as determined from the mean of the $x$ and $y$ coördinates of 209 stars and located with reference to three of the brighter stars, is

$$\alpha = 1^h\ 40^m,\ \delta = 60°\ 47'$$

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**Exploring the Earth by Boring.**—According to "From an Oxford Note-Book" in the *Observatory* for November, 1919, the president of the British Association (Sir C. Parsons), "after mentioning many marvels of the War, recurred to an old suggestion of his own (made in addressing the Engineering Section) that a boring of twelve miles should be made for exploring purposes into the Earth's crust. He had worked out the cost of the necessary cooling apparatus, and of the air-locks to relieve the extra pressure, and the time required (85 years), and considered the total cost of five millions (pounds) not prohibitive. It is quite safe to say that if the project had offered any advantage in the recent war the cost would have been regarded as trivial; but the study of the Earth on which we live has few attractions for the politician."

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**The Adoption of the Metric System.**—The following list of influential societies that are in favor of the exclusive use of metric units is furnished us by the World Trade Club, of San Francisco:—

American Institute of Electrical Engineers.
U. S. American National Wholesale Grocers' Association.
U. S. American National Canners' Association.
Associate Steel Manufacturers of U. S. America.
American Association for the Advancement of Science.
American Drug Manufacturers' Association.
American Institute of Chemical Engineers.
American Pharmaceutical Association.
American Institute of Makers of Explosives.
National American Association of Retail Druggists.
National American Association of Wholesale Druggists.
National American Scale Men's Association.
Western Association of Electrical Inspectors.
U. S. American Chemical Society.
Manufacturers' Association of the State of Washington.
American Wood Preservers' Association.
Akron Chamber of Commerce.
Los Angeles Chamber of Commerce.
Bronx Board of Trade.
Travellers' Protective Association of America.
Omaha Manufacturers' Association.
North Pacific Conference of Optometry.
Retail Merchants' Association of Texas.
Periodical Publishers' Association.
American Concrete Pipe Association.
United States Section of the International High Commission.

**Quite Simple.**—The student had to face the ordeal of an examination in astronomy.

On emerging from the torture chamber, one of his companions asked him how he got on.

"First rate," he said. "They only asked me two questions and I answered them both promptly and correctly."

"What were the questions?"

"The first was: 'What is a parallax?' and I told them I didn't know. And the second was: 'Can you calculate an eclipse?' to which I said 'No.' I'd like to see anybody answer two questions more correctly than that!"

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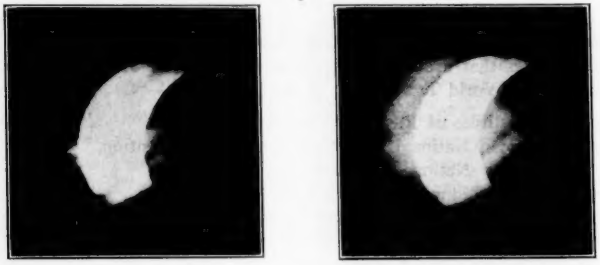
**Photographs of the Partial Solar Eclipse, November 22, 1919.**—The accompanying photographs of the partial solar eclipse of November 22, 1919, were sent us by Professor D. W. Morehouse of the Drake University Observatory, Des Moines, Ia. They are of interest for their cloud effects, and show the condition of the sky at Des Moines at the middle of the eclipse. The conditions at Northfield were very much the same.



PHOTOGRAPHS OF THE ECLIPSE OF THE SUN,
taken at Drake University Observatory November 22, 1919, at 7:50 C.S.T.

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**Errata.**—In the December, 1919, number of POPULAR ASTRONOMY, on page 693, line 15, for *A. Klose* read *M. Ebell.*

In the January, 1919, number, page 26, last line, instead of "a consequent decrease of the mass of Saturn" read "a consequent decrease of the reciprocal of the mass of Saturn".